

# C.B. NEWSLETTER

# Midnight Express

MAXIMUM RATINGS (Ta=25°C)

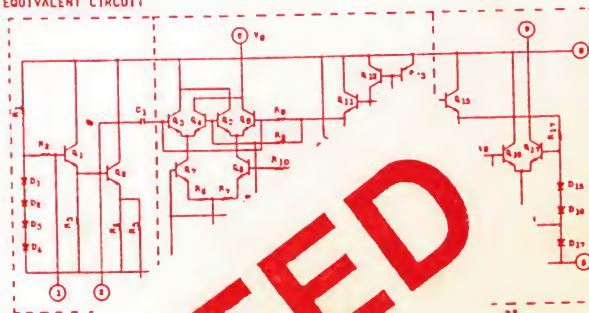
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	VCC	10	V
6 Pin Supply Voltage	V <sub>6</sub>	14	V
1 Pin Supply Voltage	V <sub>9</sub>	20	V
Power Dissipation (Note)	P <sub>D</sub>	800	mW
Operating Temperature	T <sub>opr</sub>	-30 ~ 75	°C
Storage Temperature	T <sub>stg</sub>	-55 ~ 150	°C

Note: Derated above Ta=25°C in the proportion of 4.8mW/°C.

## TA7310P

TOSHIBA BIPOLAR LINEAR  
INTEGRATED CIRCUIT  
SILICON MONOLITHIC

EQUIVALENT CIRCUIT



NEWSLETTER

letters

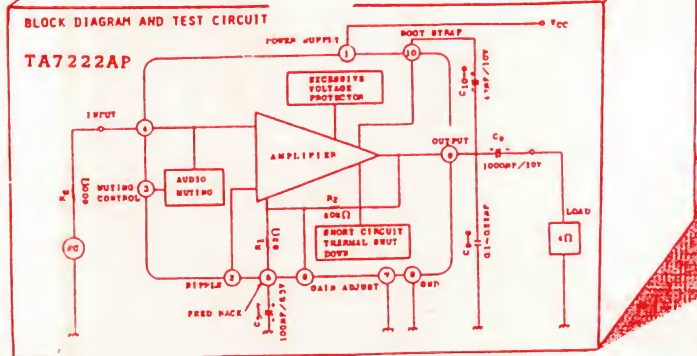
mic

# Midnight

# CONSOLIDATED

# TECHNICAL

# CB



CB Technical Newsletter

REFTEC 934

conversions

hints

Backchat module

adverts

fault finding algorithms

FREE GIFT





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## Midnight Express

Welcome to the Consolidated Midnight Express which has been compiled using extracts from the original series of four newsletters but with new, additional material included.

This book is written by rig doctors for rig doctors. We have plenty of experience but we don't profess to be experts, so if any real experts reading this screed care to make constructive criticisms, please let's have them.

Those of you who have heard of Lou Franklin will be pleased to know that he has given us his blessing. We tried to persuade him to write a contribution but, regrettably, his time is fully occupied in writing his own new book and in dealing with the CB CITY business. Those of you who have not heard of Lou - shame on you! He runs the biggest CB mail order business in America. Please invest in his books "A screwdriver expert's Guide" and "The CB PLL Data Book". Both books contain essential information which is indispensable if you intend to modify rigs in any way. Another book which might interest you is "The CB Eprom Data Book" which gives guidelines on converting CB radios to 10 metre Amateur band and includes information which is generally applicable to all frequency modifications or synthesised transceivers.

My grateful thanks are due to My wife, Gill; Dave Addy who helped with circuit diagrams; Brian Spiller who built the first Wobulator and supplied photographs to prove it and to all the other CB enthusiasts who provided ideas and articles not forgetting Steve Tonks who was one of the first to write in with ideas and now runs his own CB business.

Compiled and written by "The Specialist"

PUBLISHED IN GREAT BRITAIN BY S.J. TONKS

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### Frequency Synthesis

We felt duty-bound to give some basic theory, here, but the explanations will be kept as short as possible. Hopefully this small section will help the beginners to acquire some idea of what Frequency Synthesis is all about. Those of you who know it all, already, can skip this bit. If you need more information read Lou Franklin's "CB PLL DATA BOOK". If that is still not enough (clever clogs) there are plenty of textbooks about!

1. The VCO is an oscillator circuit whose frequency is determined by the capacitance of a varactor diode. The capacitance of this diode is controlled by the reverse-bias voltage applied to it. (Since the diode is reverse-biased, virtually no current flows).

2. The PLL chip is an I.C. with three main sections:-

a) A digital frequency divider (DFD).

b) A programmable DFD.

c) A phase detector (PD) which effectively compares the output frequencies of the two DFDs and produces an output voltage according to the difference between the frequencies.

Operation: A crystal oscillator feeds 10.24MHz into the first DFD which divides by (typically) 2048 to produce a 5kHz reference signal within the PLL chip. The VCO oscillates at an arbitrary centre frequency which is sampled and fed to the second DFD. The PD provides a voltage to raise or lower the VCO frequency until the divided result equals 5kHz. The circuit is then said to be "in lock".

Notes: The PD output is not pure D.C. so a low pass filter network is used to remove switching transients. The filter capacitor must be large enough to provide adequate smoothing without making the circuit response time too long. Larger value capacitors have a series resistor to prevent "ringing".

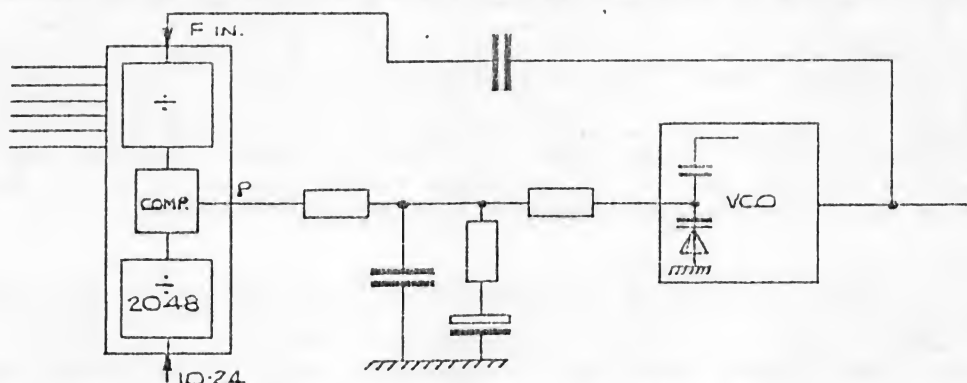


Fig 1.

The programmable DFD enables the divide ratio to be selected.

General purpose PLL chips such as PLL02A, MC145106P, MC145151P, MB8719 have no internal memory. The divide ratios are determined exactly by the channel selector codes plus the codes on the remaining inputs. Those PLL chips designed specifically for operation in just one country have an internal memory which contains only those divide ratios which produce the permitted frequencies. The divide ratios are accessed by the binary codes from the channel selector switch. There is no specific mathematical relationship between the channel selector codes and the divide ratios in the memory.

## Midnight Express

**Eproms:** An Eprom is a memory I.C. and contains a large number of memory cells, each of which can be filled with eight binary digits i.e. 1s or 0s.

A memory cell can be selected by putting the appropriate access code of 1s and 0s on the input pins. The contents of that cell will then be displayed as 1s and 0s on the output pins of the I.C.

For instance, if we put the code 11100000 into the cell whose access code is 11100000 then effectively the output duplicates the input. If we encode all memory cells with their own access codes then connect the Eprom between the channel switch and the DFD input of the PLL chip, there will be no effect on the operation of the synthesiser circuit.

This seems a little pointless, however there are only 40 possible channel selector codes but several thousand memory cells. If we encode only those 40 cells accessed directly by the channel selector (which will give the standard frequencies), we still have several thousand cells left in which to put other codes for different frequencies.

The channel selector switch will have from 6 to 8 outputs which may be connected to the access pins of the Eprom. However, the Eprom has ten or more access pins; consequently by using a band switch to put codes on the spare access pins we can select different banks of memory cells which can be programmed to give various frequency bands. For more information on the use of Eproms see our "CB EPROM DATA BOOK".

With dedicated ICs, such as the LC7137, reprogramming is not possible as the codes are stored in internal memory. With ICs like the MC145106P, however, we can use divide ratios between approximately 10 and 320. Such ICs lend themselves readily to external reprogramming. Note, however, that they will not work at frequencies much greater than 3 MHz. The MC145151 is an exception and will work at more than 30 MHz.

To sum up, then: with these versatile ICs the manufacturers saved money by designing the channel switch, itself, to present the divide ratios (in binary form) directly to the IC programming pins. Sometimes, as in the case of the later Cobra 148 GTL, a couple of binary adder ICs (MC14008B) are interposed between the channel switch and the synthesiser IC. Extra codes can thus be added to the switch codes to alter the programming information. It is generally easier for us to use an Eprom and encode it with the codes we need for the required channels.

## Channeling Channels to Mixers

Virtually all the CB synthesisers you will see use a 10.24 MHz crystal to produce a 5 kHz or a 10 kHz reference within the IC (or sometimes a choice of either). This reference frequency actually determines the channel spacing. If, therefore, you try to produce extra channels by substituting, say, a 10 MHz crystal then you may get your 40 channels, but the channel spacing will be 9.766 kHz, not 10 kHz. Also, if the IC uses different codes for TX and RX you will receive on a channel far removed from that on which you transmit. Even this difficulty can be overcome by using different crystals for TX and RX (although the channel spacing will still be awry) but a further problem remains:  $10.695 - 10.24 = 455$  kHz which is the 2nd I.F.  $10.695 - 10.0 = 695$  kHz which is not; so unless you use a separate 10.24 MHz oscillator to feed the second mixer you will not receive very much!

On the following pages we go into this problem in somewhat greater detail.



### Expanding the LC7137

Fig.2 shows the normal 10.24 MHz reference crystal connections to the LC7137. Changing the reference crystal is a quick way to add extra channels. It is also a quick way to end up transmitting on one channel and receiving on another if you don't understand what you are doing!

Fig.3 shows a modification which will produce about 20 more useable channels. Such a modification, by the way, would not be legal and the bare details are given simply to illustrate the way in which the PLL operates.

We carried out some computer calculations using various crystals which could be obtained from "Birketts" at a very reasonable price. The table on the next page shows the result of switching in different reference crystals for receive and transmit. Note how the RX and TX frequencies gradually drift apart in the columns marked "D Hz". An error of up to about 500 Hz is tolerable but communication becomes distorted and range is considerably reduced if the discrepancy is significantly higher than this.

Since the Intermediate Frequency relies upon the result of  $10.695 - 10.240 = 0.455$  it is essential to add a separate 10.24 MHz oscillator as shown in Fig.4.

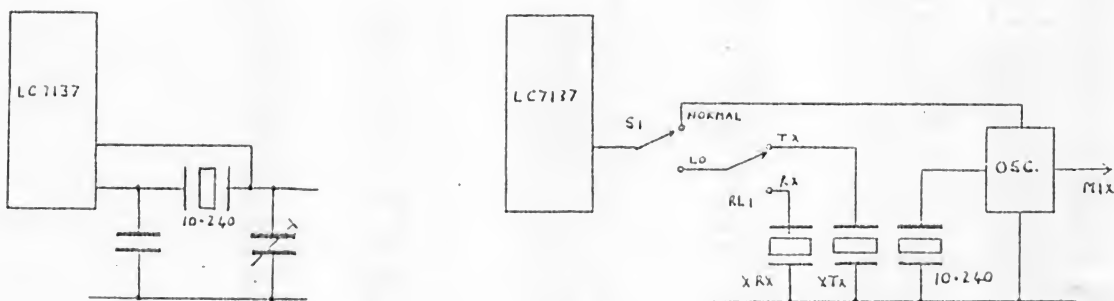


Fig. 3

Fig. 2

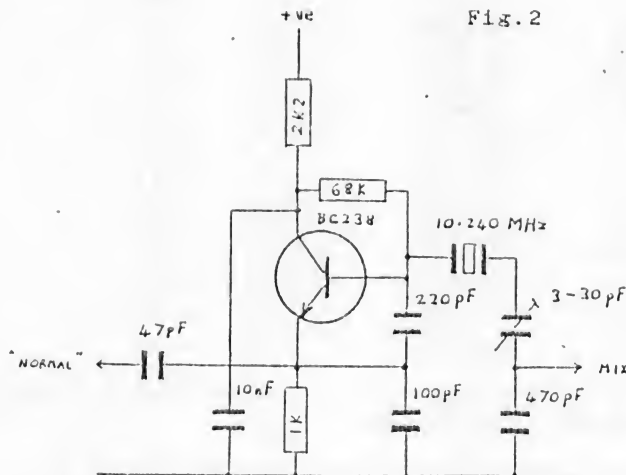


Fig. 4

# Midnight Express

The table shows how difficult it is to produce useable channels with crystals other than the correct reference frequency of 10.240 MHz. It is also evident that the further the new crystals are removed from 10.240, the smaller the number of useable channels produced, because the inter-channel spacing becomes much less than 10kHz and the variation in channel spacing between TX and RX increases.

First crystal pair				Second crystal pair		
Ch.	rx MHz	tx MHz	D Hz	rx MHz	tx MHz	D Hz
40	27.7767	27.7782	1478	27.5846	27.5864	1765
39	27.7668	27.7682	1430	27.5749	27.5766	1675
38	27.7569	27.7583	1383	27.5651	27.5667	1585
37	27.7471	27.7484	1335	27.5554	27.5568	1495
36	27.7371	27.7385	1287	27.5456	27.5470	1405
35	27.7273	27.7285	1240	27.5358	27.5371	1314
34	27.7174	27.7186	1192	27.5261	27.5273	1224
33	27.7075	27.7087	1144	27.5163	27.5174	1134
32	27.6977	27.6988	1097	27.5065	27.5076	1044
31	27.6878	27.6888	1049	27.4968	27.4977	954
30	27.6779	27.6789	1001	27.4870	27.4879	863
29	27.6680	27.6690	954	27.4772	27.4780	773
28	27.6582	27.6591	906	27.4675	27.4681	683
27	27.6483	27.6491	858	27.4577	27.4582	593
26	27.6384	27.6392	811	27.4479	27.4484	503
25	27.6285	27.6293	763	27.4382	27.4386	412
24	27.6187	27.6194	715	27.4283	27.4287	322
23	27.6088	27.6094	668	27.4186	27.4189	232
22	27.5989	27.5995	620	27.4089	27.4090	142
21	27.5890	27.5896	572	27.3991	27.3992	52
20	27.5792	27.5798	524	27.3893	27.3893	-38
19	27.5693	27.5698	477	27.3796	27.3794	-129
18	27.5594	27.5598	429	27.3698	27.3696	-219
17	27.5495	27.5500	382	27.3600	27.3597	-309
16	27.5396	27.5400	334	27.3503	27.3499	-399
15	27.5298	27.5301	286	27.3405	27.3400	-489
14	27.5199	27.5201	239	27.3307	27.3302	-580
13	27.5100	27.5102	191	27.3210	27.3203	-670
12	27.5001	27.5003	144	27.3112	27.3105	-760
11	27.4902	27.4904	96	27.3014	27.3006	-850
10	27.4803	27.4804	48	27.2917	27.2907	-940
9	27.4705	27.4705	0	27.2819	27.2809	-1030
8	27.4606	27.4606	-47	27.2722	27.2710	-1121
7	27.4507	27.4507	-95	27.2624	27.2612	-1211
6	27.4408	27.4407	-142	27.2526	27.2513	-1301
5	27.4310	27.4308	-190	27.2429	27.2415	-1391
4	27.4211	27.4209	-238	27.2331	27.2316	-1481
3	27.4112	27.4110	-285	27.2233	27.2217	-1572
2	27.4014	27.4010	-333	27.2136	27.2119	-1662
1	27.3915	27.3911	-381	27.2038	27.2020	-1752

Note: the "D Hz" column is calculated from the 8 digit frequencies of which only 6 figures are printed in this table.

Since the reference frequency is now taken from crystals which no longer divide down exactly to 5 or 10kHz (e.g. 10.240/2048 = 5kHz) the channel spacing is no longer exactly 10kHz but slightly less.



### Backchat

This conversion board was obtained from Tither Research some time ago at a cost of £14-50. Unfortunately this company has disappeared from Jarrow and very few boards are left. The unit is specifically designed for connection to a legal rig using the LC7136/7 (or any similar IC used in an A.M. rig) which has BCD inputs from the channel switch (except for channel 40 code which is zero).

Connection is fairly straightforward if the diagram supplied is followed carefully. I did not like the action of the pink wire which closes the squelch whilst the unit speaks the channel number. It was disconcerting to switch to (apparently) a clear channel, to hear the channel number spoken, then be blasted by the voice of the channel occupant as the squelch opened again. It made "flicking through" very tedious. Consequently I disconnected the pink wire on mine.

I soon tired of the American voice and connected the output via the mic gain pot on my Sapphire X4000 so I could reduce the voice to zero volume for the purpose of casual "flicking", returning to full volume for "eyes off" use whilst driving. If you forget which channel you are on, simply flick the channel switch forward and back again and "Backchat" will tell you. If you are flicking through, "Backchat" waits about half a second after you have stopped before announcing.

Recently I offered the unit to a blind person who could obviously make far better use of it than I. Unfortunately his rig is an Audioline homebase which, in common with most Uniden chassis, has peculiar channel switch codes which also feed the channel display. It is possible, however, to make a small veroboard conversion unit to fit between the channel switch and the "Backchat" module. The unit employs an Eeprom to convert the Uniden codes to BCD. A slight problem arose in that the Backchat spoke the tens digits incorrectly. I traced this fault to the need for the Backchat to have at least 5 volts input from the channel switch, which the Eeprom is unable to supply. The solution was to insert the four diodes, which you see in the diagram, to increase the voltage. The prototype Eeprom has not suffered from this alteration, so far.

Conclusion: the "Backchat" module is very cheap when you consider the cost of the components. It is MOST effective for blind people and can be useful for normal mobile operation. Some people have fitted it purely for its novelty value, which inevitably wears off, consequently you might acquire one second-hand. The module is large and, although it fits easily beneath the board of the bigger rigs, it must be taped to the outside of smaller rigs. The Eeprom conversion allows it to be used in the big Audioline homebase and outside the smaller Audioline/Uniden/Tandy rigs. If you know a blind person "on the air" do, please, offer him this addition which can make life so much easier.

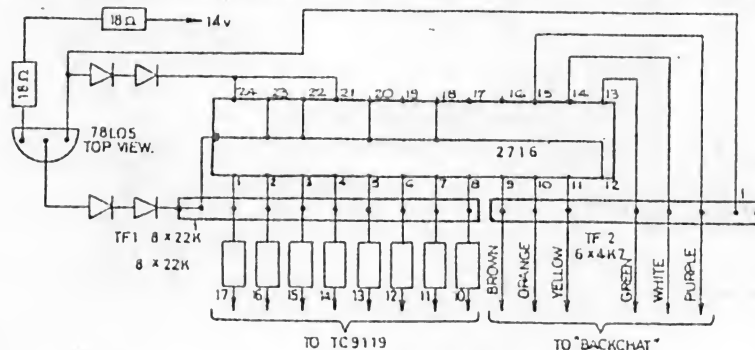


Fig. 5

FM Noise squelch

FM Noise squelch

Four identical prototypes have been built so far and all are working satisfactorily - three in Amstrads and one in an Audioline. The intention was to design a squelch which would react to the no-carrier-hiss and turn it down to a barely audible level without reacting, unduly, to overmodulation. The result was excellent for homebase use but gave problems for mobile. In my car there is a great deal of ignition interference and the unit reacted to it in such a way that the rig went quite mute, the moment I started the engine. With the squelch control turned back, it then allowed a lot of the undesirable noise through.

Trials in an Amstrad rig for homebase were far more acceptable. On long distance copies, the squelch could be adjusted so finely that the hiss between individual words was cut down, rather like a fast-acting "Superkrunch". However, when the rig was transferred to a location in the middle of a busy town, the results were poor without a crystal filter because the hiss was actually reduced by swamping from local transmissions. With the hiss level reduced, the squelch failed to react and allowed the remaining noise through. A crystal filter improved the operation considerably, however.

The unit, therefore, is most suitable for use in country areas, or in small towns when a crystal filter is fitted. The rigs which benefit most are those with the most noticeable hiss between transmissions. It is worth trying it for mobile use but don't expect good results unless you have a car with low ignition interference or a diesel engine.

Construction is quite straightforward and component values are not critical. The value of the existing squelch pot is not too important, either, since it is in parallel with a 10k resistor. In the Amstrads The RF Gain control was used for the noise squelch, leaving the normal squelch control to work as originally. This method is useful for keeping out quiet "bottom-of-the-box" conversations which the noise squelch, of course, will not. Fig.6 shows the squelch as fitted to an Amstrad (Spinneytronic, Murphy, Fidelity 2000 etc.).

In Uniden chassis rigs, disconnect the base of TR12 from everything else and TR12 then can be treated as TR1 in Fig.6. The input comes from pin 7 on the FM demod IC.

Turn the FM squelch control fully clockwise then adjust the trimmer in the FM squelch circuit until the hiss can be heard faintly.

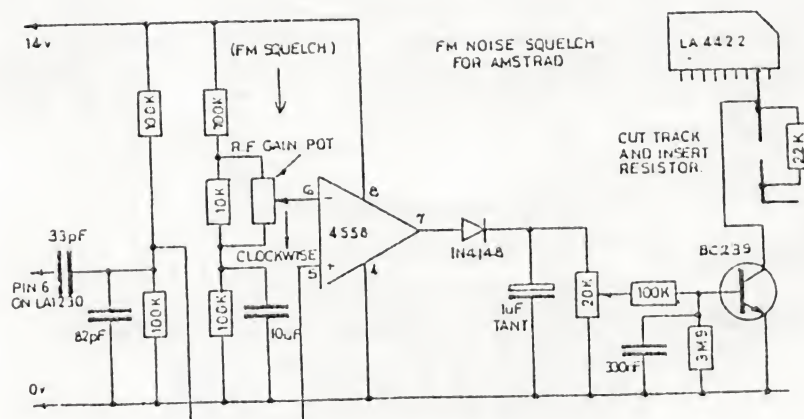


Fig. 6



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By popular request, the following flow charts should help in fixing the majority of faults which you might come across.

You should have a fine-tip soldering iron, solder sucker, high-impedance DC voltmeter, frequency counter and an oscilloscope, too. It is possible to manage with a 'scope of only 10MHz bandwidth, but 20 or 30MHz is better.

### Fault Finding Chart. Symptom - No TX, no RX

Ensure P.A. switch is off !

Is rig lighting up or speaker hissing?

Yes No>> Check Power supply

- V Fuse
- V Power lead
- V Protection diode
- V Power line filter coil(s) in rig
- V Wires from power socket inside rig
- V Copper tracks on board
- V earth from mic socket to board
- V On/Off switch
- V

Is voltage on PLL Vcc pin correct? (usually between 5v and 9v)

Yes No>> Check zener diode near PLL IC

- V feed resistor to zener
- V copper tracks associated
- V voltage regulator or
- V voltage reg. transistor and associated zener
- V

Is 10.24 MHz oscillator working?

Yes No>> Check crystal by replacement

- V associated capacitors/trimmers
- V copper tracks around oscillator
- V (Some rigs need other crystal oscillators checking.

too)

- V PLL IC by replacement
- V

Is VCO oscillation present?

Yes No>> Check correct DC voltage present

- V dirt on PCB
- V Varactor diode
- V oscillator coil continuity/core
- V VCO transistor or IC
- V

Is VCO oscillation correct frequency? \*

Yes No>> Check adjustment

- V DC voltage from PD filter circuit
- V associated components
- V dirt on PCB
- V copper tracks
- V

Is 10.24 output appearing at both TX and RX mixers?

Yes No>> Replace faulty components/ repair broken track or connection

V

Check for o/c, s/c starting at aerial socket and working back through RF input and output stages. Inject a signal from another rig to assist.

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\*VCO and PLL operation can be checked by hanging a DC voltmeter or 'scope across the PD output of the PLL IC. Each change of channel should alter the voltage by the same number of millivolts. The PD output feeds the varactor diode and changes its capacitance for each channel frequency.

### Fault Finding Chart. Symptom - RX but no TX

Ensure P.A. switch is off !

Check voltage supply line to output transistor during TX. If low or 0v check On/Off switch, modulation transistor (or transformer and series diode) in AM rig, associated tracks and connections, particularly to HI/LO power switch, AM/FM switch.

Can transmission be picked up by second rig, (without aerial) on same channel, placed close to faulty rig?

No Yes>> Check RF o/p transistor and insulator

V RF driver transistor and insulator

V for burnt coil in output stage

V for missing/broken ferrite adjusters

V for broken tracks/bad joints

V Adjust ferrite cores, slightly, using second rig to monitor for increase in output power. Care !

V

Does voltage on TX/RX track change between TX and RX (see TX LED if fitted)

(less than 1 volt and more than 5 volts on PLL IC TX/RX pin if used) ?

Yes No>> Check microphone switch and wires

V Roger Beep if fitted

V wiring from mic socket to main board

V TX/RX switching transistor

V PLL IC by replacement (but only if IC has TX/RX pin)

V

Does 10.695 (or 10.692) MHz oscillator function, if present ?

Yes No>> Replace crystal

V check power feed is present during TX

V transistor etc.

V

Does VCO operate at correct frequency during TX?

Yes No>> See note at bottom of previous page

V Check Trimmer capacitor near VCO if present

V PLL IC

V

Check transmit stages from VCO onwards, using scope and frequency counter.

(Someone may have altered the setting of the RF coil cores but resist the temptation to fiddle with these unless you can monitor the results of your adjustments, at each stage.)

Hands up all those who don't know why rigs have wax on the VCO section! The wax is there to prevent "microphony". Vibration of the VCO components can alter the frequency to cause - yes! FM modulation at the vibrating frequency. Wax is also lovely stuff for use on ferrite cores which might otherwise move out of adjustment.



Fault Finding Chart. Symptom - TX but no RX

Ensure P.A. switch and Squelch control are off.

Does "S" meter register incoming signal when aerial is connected? (Use your own rig, if necessary, to generate a signal)

No Yes>> Check microphone

V                   loudspeaker

V                   EXT SPKR socket and connections

V                   Introduce signal into input pin of audio IC. Replace IC if

faulty

V                   Ensure squelch transistor is off

V

Hold a 10.695 oscillator near to the IF stage.

Does the signal register on the "S" meter?

No Yes>> Check to ensure the 10.24 signal is reaching the IF mixer stage

V                   to ensure the VCO signal is reaching the RF mixer

stage

V                   RF input transistor and following transistors

V                   Use second rig to produce signal and trace through

input stages, tuning cores if necessary.

V

Check filters by replacement

Check MC3357 IC (if present) by replacement.

Notes: If rig has no "S" meter connect voltmeter to IF output stage. Hiss or crackling on transmitted audio can have several causes: Mic switch dirty (spray with WD40); Dirt on PC board (clean with Propan 2-OL); Faulty Audio output IC (if this is part of the audio circuit during transmit); faulty microphone amp IC (usually a 4558, if used); faulty deviation preset; faulty varactor diode. Noise or whistling can also be caused by an unstable VCO, usually as a result of modification to add extra channels: a frequency counter will usually show this up.

Noise on received audio: I came across one instance where this was caused by a dying RF output transistor! Bad connections in aerial socket, mic lead, mic switch, speaker connections and EXT SPKR socket can cause it, as can a faulty audio IC.

A general note, now, about VCO frequencies. Most legal rigs use dedicated PLL ICs which have a TX/RX pin to alter the divide ratio between RX and TX. The VCO frequency is changed in this way. Sometimes the change isn't great and the output voltage from the PD pin has sufficient range to do the job, alone. Sometimes, as with the LC7137, the VCO frequency has to move from 17MHz to 13MHz between RX and TX; consequently a trimmer is switched across the VCO coil during TX to shift the frequency downwards. You will appreciate, therefore, that if the VCO coil or the trimmer should get slightly out of adjustment, the rig might work on TX, but not RX, or vice versa. Sometimes only one or two channels are affected. On some rigs, if the VCO can't be "pulled into lock", transmission is inhibited altogether. You can check this by measuring the average DC voltage on the "LD" pin of the PLL IC. You can also monitor the DC voltage from the PD pin after it has been filtered and smoothed by the associated resistor/capacitor network (it is a pulsed output) to ensure that it alters by a fixed amount, each time the channel is changed.

Some rigs (for instance those which use the PLL02A) do not alter the VCO frequency between RX and TX. Instead a different crystal (e.g. 10.695) is used to create the TX frequency by mixing with the VCO output. Any fault in the VCO, here, will affect both RX and TX.

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### Microphone connections

The connections given below cover most of the common power- and power/echo microphones. However, the manufacturers do seem to change wire colours so don't take the colours I have given as gospel truth. If the microphone fails to work you will have to start from scratch. By the way, always but ALWAYS measure the battery voltage with the microphone keyed, before looking for a fault !

IC ECHO MIKE WE990	SIRTEL ECHO MIC CBE-2002
white-----RX	blue-----RX
black-----TX	white-----TX
red+braid---com	black+braid-com
yellow-----mic	red-----mic

ALTAI DM-315E	ALTAI DMC-510
MIRANDA DM-311	
blue-----RX	red-----RX
white-----TX	white-----TX
black+braid-com	black+braid-com
red-----mic	yellow-----mic

DENSEI DM307P	ELEC DM-101A
blue-----RX	green-----RX
white-----TX	blue-----TX
black+braid-com	red+braid---com
red-----mic	yellow-----mic

TURNER +3B	PACE MIKE
black-----RX	black-----RX
blue-----TX	red-----TX
red+braid---com	braid-----com
white-----mic	white-----mic

LESON CH219	CHEIZA (power mike)
white-----RX	red-----RX
black-----TX	white-----TX
braid-----com	black+braid-com
red-----mic	yellow-----mic

TURNER M+2/U REALISTIC NOISE CANCELLING	
red-----RX	black-----RX
black-----TX	red-----TX
braid-----com	braid-----com
white-----mic	white-----mic

LESON DT-252A	CARDIOD DYNAMIC BSA-610A
red-----RX	blue-----RX
green-----TX	white-----TX
blue+braid--com	black+braid-com
yellow-----mic	red-----mic

The LCM board (K.S. Services)

Fitting to Formac 88 and 120, Major M120 and similar rigs about 200mm x 160mm x 55mm which use the PLL02A IC.

These rigs contain up to three extra circuit boards - crystal board, FM board or Roger Beep - so it can be hard to find room even for a small board like the LCM (44mm x 36mm x 8mm). The following description refers to the Major M120 but please note that the Formac has an extra capacitor between R103 and Q16 which must be transferred to the track-side of the board; also, you must remove terminal pins 15 (blue) and 16 (green wire) and replace wires on track-side.

Temporarily remove the 10.240 crystal. Transfer R76, R77 (large blue 150 Ohm resistors) to the track-side of the board. Similarly, transfer the front two diodes from the underside of the channel-change board to the track-side (observing polarity).

Connect LCM board as per K.S. instructions with 4" of ribbon cable and use double-sided tape or blue tack on the Eprom itself to attach the LCM assembly to the side of the channel-change switch. Check for short circuits then replace the 10.240 crystal.

The Major M120 has a push-pull switch which can be used to change bands.

My grateful thanks to Mr Ball who contributed this piece (and earned a tenner). I have cut the original text by two hundred percent and hope I have not lost any important points in the process. The LCM board by K.S. Services is designed to convert most PLL02A rigs (please enquire before ordering) to legal frequencies. I believe that it might also provide an extra 40 below-the-lowest and, of course, you can retain the original channels, too, if you wish (not legal, however).

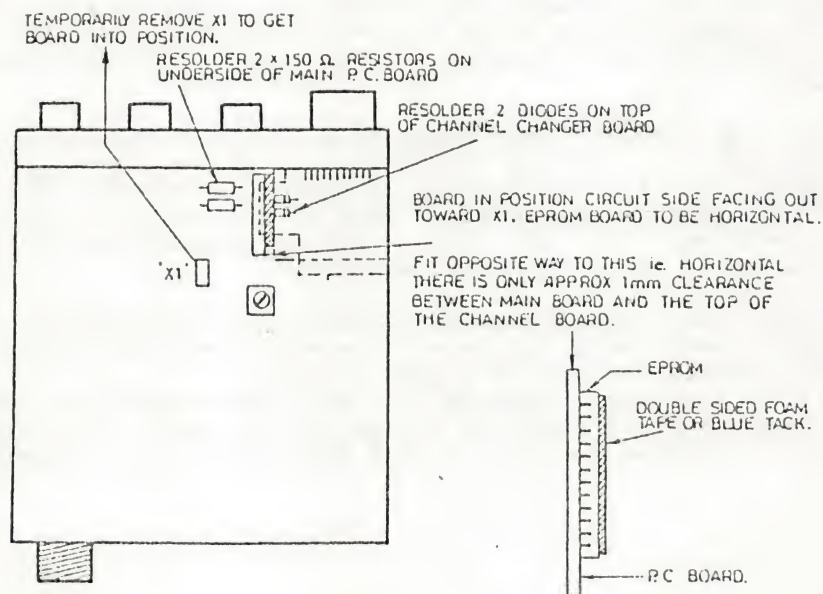


Fig. 7



General Information

We've had several sets of various make with the following fault: No transmission or low or erratic RF output. In most cases the ON/OFF switch was faulty. Audio output is often not affected. Note, however, that a faulty R.F. output or driver transistor can produce the same symptoms.

Use a bridge rectifier to protect rig against reverse polarity.

Noisy crackling from a microphone switch can, in most cases, be cured by applying a light oil or WD40 to the contacts. It can also be used in crackling squelch or volume controls and to clean the outside of rigs and improve the clarity of channel displays.

Instead of having several power leads with different plugs trailing across the repair bench, cut all your power leads down to 6 inches and fit them to a connector block with just one pair of wires going back to the power supply. This idea makes it easier to find the correct plug and is much tidier.

Mic socket pins which are split can close up and cause a bad connection. Similarly, aerial socket segments can open out and cause a bad connection.

When knobs are loose, instead of wrapping tape round control spindles, insert a screwdriver to open the slot.

If the "S" meter lens is scratched, use 400 grade abrasive paper until the lens is opaque, then polish with Brasso. Sounds extreme but works easily and quickly!

Instability on TX or intermittent TX can be caused by loose screws holding PCB to chassis. This fault has been found on Cobra 148, Superstar 120, Superstar 360, President KP77 and is known to occur on many others.

Multimodes - To convert Fine-Tune into a KC shift, trace the centre connection from the pot to the varicap diode. There is usually a diode in this lead so the pot is only in circuit on RX. Wire the pot straight to the varicap diode. One end of the pot will be grounded and the other will have no connection. Connect the n/c side to the 9v regulator to give 4kHz shift each way.

WARNING Some power transistors and regulators, apparently, contain poisonous substances so be sure to wash hands and nails meticulously after handling broken or cracked devices.

A danger exists on some homebase rigs and power supplies. They have only two-core cable or switches in the neutral wire! Also earth tags should be bolted to chassis, NOT pop-riveted to a transformer lug.



- Handy Hints -

Cybernet PTBM134A0X chassis squelch improvement. Remove the front leg of R60 (10k) from the board (RHS front of PCB). Solder a wire into this hole (connects to Q14 collector) and solder the free end to the post near the front of the board which has a wire (usually blue) going to the top (loud) end of the volume control.

Power output lower than usual - replace L4 (22uH), L5 (68uH) and L7 (24 turns of 28SWG enamelled copper wire on a 27R resistor).

Almost no power output on TX. Monitor rig reveals weak, noisy TX. Try turning CT1 slightly because maladjustment can cause this effect.

Volume control turned down but continues to give sound dependent on squelch setting! Try replacing C109 which might be open circuit.

No RX no TX - try replacing Q18 (2SC1318).

10nF cap across vol. control acts as treble cut if rig has no tone switch.

To alter the 10.24 crystal frequency by several kHz connect a Toko TKACS34342 discriminator coil in series with it. Use the two outer pins of the three.

To change CH9 to CH19 for mobiles, disconnect track from LC7137 pin 9 and reconnect to pin 8. Add 2 off 1N4148 diodes with cathodes (bar) connected to common ends of D251 - 256 and anode ends to c' and b' segments on CH display. On rigs without a CH9 switch, use a changeover switch to disconnect power from CH switch and CH display and to connect power (up to 8v) to pin 8 and to the diodes added to produce "19" on CH display.

Crystal filter: Remove C67 (2pF) between T8 and T9. Fit the crystal filter in its place with the centre lead soldered to T8 or T9 can. Tune T8 and T9 for optimum signal strength, then readjust slightly for best sound on a loud but distant signal. If T9 is not present, fit a 85FC4402EJ 7mm Toko coil.

Cybernet PTBM135A0X chassis - no TX or RX until rig has been on for a few minutes - I haven't traced this fault to the exact component but it appears to be one of the capacitors next to the VCO coil becoming very temperature-sensitive (try replacing the 82pF cap). Retuning VCO appears to cure fault but then the rig can lose channels when it is hot.

Cobra 148 (later version): to silence the "Roger Bleep", simply disconnect C162 near the microphone socket (a 2u2/25v electrolytic which is not numbered on early circuit diagrams and labelled C270 on later ones!). The duration of the bleep is controlled by the value of this capacitor.

Cobra 148 (early version) Regulator transistor TR39 often blows and can be replaced with a TIP42. Note that this is PNP. If you fit an NPN by mistake it will oscillate and produce a howl from the speaker. Similarly A.M. modulation transistor is also PNP and may be replaced with a TIP42. If an NPN is used there will be no amplitude modulation on TX.

- Suffers from "lazy needle" problems. Short circuit either D7 or D8 --NOT BOTH-- which are in series near the centre of the board. Adjust VR1.
- Bad modulation on TX can be caused by PCB securing screws loose or missing. Carrier on SSB, no mod on AM FM SSB, RX LED stays on during TX - replace TR37.

Cobra 150 GTL can be converted to UK channels quite easily since the channel switch contains a section with no "jumps". Use a 20.39MHz crystal. Remove the green and blue/white wires from the channel switch board and join them to the purple/white position on the board.

-Ham International Rigs-

(PCMA001S) Nato 2000, Tristar 797, 848 (PCCW001S bleep board)  
(PTBM048A0X) Colt 485DX (Black Shadow)  
(PTBM059C0X) Ham Multimode II, Ham Jumbo (PTOS006A0X crystal & VCO board),  
Major M-360 (PTSY016A0X crystal & VCO board)  
(PTBM092C0X) Colt 870 PTOS008A0X crystal board, PTZZ033A0X FM board)  
(PTBM094C0X) Ham Viking, Formac 88 (PTOS008A0X crystal board, PTZZ033A0X  
FM board)  
(PTBM106A0X) Lafayette HB-940, New Formac 88, Formac 120, Colt 720  
(PTOS008A0X crystal board, PTZZ033A0X FM board)  
(PTBM121D4X) Concorde II, Hy-Gain V, Tristar 747, Colt Excalibur  
(PTOS011A0X crystal board)  
(PTBM125A4X) Tristar 777 and Superstar 2000 (PTZZ080A0X bleep board)  
(PTBM133A4X) Concorde III

Ham Multimode II: The Roger Bleep can be switched off by using a SPST switch as follows: Take the wire off post 3 and solder it to the slider of the switch. Connect post 3 to the "on" tag of the switch. The "off" position should be connected to post 5. (Do not remove the wire already there).

Fitting crystal filters:-

PTBM059C0X Replace C122 (27pF) with filter.

PTBM121D4X Replace capacitor labelled C128 (27pF) with filter. ALSO, for all these rigs, cut the track to T13 and connect this side of the filter to the spare pin of T13. Retune T10 and T13.

PTBM133A4X Simply replace C117 with filter.

PTBM125A4X and PCMA001S replace C120 with filter.

PTBM092C0X and PTBM106A0X Replace C63 with filter.

PTBM121D4X - modulation is seldom brilliant on FM. Firstly ensure that the TX frequency is absolutely right. Use a frequency counter with at least 7 digits. Lift out R29 (100k) near the VCO block and cut the track between TR1 and the VCO block. Solder a 4k7 resistor across the break in the track. Connect a 1M resistor from the VCO block side of the 4k7 to C32 (where it joined R29). The Audio AGC action is fierce so, to reduce it, cut the track between D38 and the other components (C175, C173, R150), or lift one leg out of the PCB. Connect a 1k preset in series with D38. Adjust for the most pleasant modulation. The Altai DM315E Echo mike works well. The AGC action can also be reduced by soldering 18k in series with C175 (3u3) next to RV14.

- No TX AM or FM caused by DC switch buffer Q36 going open circuit (2SD837). Poor TX caused by burning of RF coils - quite hard to spot. Make sure you rewind them with the same gauge wire! (And keep the output power down to 5 Watts).

- Extend the Tuning range by replacing L1 (2u2H) on PTOS012A0X crystal board with a 3u9H inductor and remove capacitors C5, C7 and C7.

- Note that RV14 is the limiter for A.M. and RV13 is the Amplitude Modulation Depth adjuster. Using this to (apparently) turn output power up will reduce modulation depth almost to zero!

PTBM125A4X - lights dimming or fuse blowing on TX can be caused by D1 on PTZZ080A0X bleep board.

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PTBM106A0X: Common fault is no TX or intermittent TX caused by faulty D13 near modulation transformer.

PTBM048A0X KC shift - remove D4 and D5. Connect lead from middle tag on clarifier to D4 position on board, negative end. Connect spare tag on Clarifier pot to 9v regulator on board.

PCMA001S (Nato 2000) : RX OK but erratic RF power output or no output can be caused by the demise of diode D1 on the PCZS0001 board. Replace it with a 1N4001. (In case you didn't realise it, the two "ICs" on this board are not ICs at all: one is empty and can be thrown away. The other has shorting links across opposing pins.) The same fault on a Tristar 777 is caused by D1 on the relay board.

- To switch the bleep on and off, insert a switch in one leg of C601. To shorten the duration, change C601 (10uF) to 3u3F. To lower the tone, add 22nF across C605.

## Audioline/Uniden/Uniface/Realistic

### Crystal Filter

If you use a 1k impedance crystal filter from P.R. Gollage, simply replace the ceramic filter and retune L4 and L3. If you use the early Ambit 3k Ohm crystal, replace L4 with a TOKO KACSK3892A Transformer (red) and retune L4 and L3. The new L4 will usually need to be screwed downwards. If distortion is evident disconnect the track between the filter and L3 and reconnect the filter to the unused pin on L3, which is a higher impedance point. If you use the later 1k8 Ambit filter you may get away with the standard L4 but, if distortion is evident, replace it.

### RF Gain Control

The smaller rigs have no R.F. Gain control: unless you happen to snip through the wire of the resistor in series with the squelch pot! Use the tone switch to disconnect this resistor and you have a squelch or R.F. Gain control at the touch of a button. Very useful for fox hunting.

The R.F. Gain control on the big rigs is very abrupt in operation. Replace R2 (1k5) with about 6k8 for smoother operation. Also, D1 diode goes short circuit; results in loss of sensitivity. May need to replace with 2 ordinary diodes in series. D9 open circuit can cause the same symptoms.

### Squelch Operation

The squelch control on the Uniden/Audioline rigs is very wishy-washy. The operating point can be made much sharper by replacing C5 (10uF) with 1uF. C5 is near the centre of the PCB, just behind the loudspeaker clearance area.

### Modulation Improvement

The modulation tends to be muffled and a modification was offered in What CB Magazine, as follows:-

change	from	to	
R69	10K	8K2	
R70	12K	47K	
R71	10K	4K7	Also, add a 4n7 capacitor
R80	560R	330R	in parallel with R81 and add
C74	47n	100n	an 82pF capacitor in parallel
C92	68n	33n	with R79.
C93	680p	330p	
C98	1uF	100n	
C99	22n	100n	



## Midnight Express

### Tricky Uniden Faults

- VCO locks on TX but not RX - replace TR18 2SA105.
- No RX and both RX and TX lights on - replace TR17 2SC1815.
- RX jumping in and out when in TX. Both lights on but set will not lock. Removing RX wire from mike socket allows normal TX operation. Fault is caused by Audio IC - replace.

President KP77 homebase (PC-902AA) - TX power loss with "motor-boating" on some channels can be caused by faulty TR202 in PSU board (PC-410AC). Replace with TIP41.

Amstrad 900, 901, Mustang CB3000, Fidelity CB 2001FM, Harvard 402 MPA, Spinneytronic and Harvard H-407 homebase.

- No RX no TX may be caused by the small copper foil burnt out on the mike socket PCB from the common (0v) pin.
- The square FET (K107E1K) can be replaced with a 2N301 or a 3SK45. Fit so that the metal tag is to the left as you look from above with the fascia towards you.
- Replace C71 (2pF) with the crystal filter, as in the Cybernet 134 board (see above).
- Make the squelch action snappier by changing C99 (1uF) to 100nF. C99 is hidden beneath the cableform towards the front of the PCMA002F board.
- These rigs use an inductor to adjust the 10.24 MHz oscillator. If the inductor becomes damaged, replace with CIRKIT part 119ANA5874HM. The value of C18 (33pF) may need to be changed.
- Audio distortion on high volume: replace C107 (1000uF) next to audio IC.
- Remove RF power transistor and solder up the gaps in the chassis to improve heat sinking and reliability. The big 3R3 can be shorted to increase power output but an extra heatsink will then be needed.

Maxcom/Midland rigs - often suffer from spurious emissions during TX, which can be seen on an oscilloscope connected across the dummy load. Symptoms include sending frequency meter or SWR meter wild and possible interference to radio receivers. The effect seldom causes any obvious problems with transmitted modulation, but power output may read less than 3 Watts. Cause is usually maladjustment of the RF can nearest the left side of the chassis (looking at component side of board with knobs towards you).

- Replace the existing ceramic filter with a P.R. Colledge 1k crystal filter. Remove C110 (27pF) and R189 (390R) and retune T8.
- Sensitivity can be improved by desoldering one leg of C207 (but leave it in place).
- Power output can be increased by changing R147 to 1 Ohm.
- "Lazy needle" can be cured by changing R128 (4k7) to 1k. cut brown wire to "S" meter and insert a 270R resistor. Connect a germanium diode from the other tag of the "S" meter to the 270R resistor. (The diode cathode band should be at the non-meter end of the resistor.) Adjust Power meter to 4 Watts with RV103.

Midland AM - No TX or low TX caused by R330 (10R) going open circuit, removing supply voltage from the RF driver.

Chaiza, Academy, Fidelity 1000, 3000FM, Sapphire X2000, Lake Manxman, Commtel, Tokai, Elftone, Barracuda.

- In these rigs the 10.7 ceramic filter sits between T1 and T2 and may be replaced directly with a crystal filter. You won't even need to make any adjustments.
- Low power output or no R.F. output is often caused by the demise of R65 (8R2) which goes high-resistance. R.F. output is invariably low on

## Midnight Express

these pins in any case and may be increased slightly by replacing Q17 with a 2SC1815. Note, however, that the most common reason for NO R.F. output is that a long screw has been forced into L6 (Replace with a Toko 199CCA127EK but DO NOT connect its centre pin!)

- No channel display, no TX, no RX - replace Q9 with a 2SD325 or BD241. Also check zener D11.
- VCO range can be increased by adding an 82pF ceramic capacitor in parallel with C216 (80pF). A further increase may be achieved by changing C224 (27pF) to 22pF.

Telecom TC9000/Grandstand Gemini/Grandstand homebase crystal filter.

Replace the ceramic filter with a 1k filter and remove R85 (330R).

Harvard 400M - poor RX - replace 3N201 near trimmer next to o/p transistor. A 3SK45 can be used.

Interceptor crystal filter- Fit crystal in place of FT-1; Replace transformer RX4 with KACSK3892A; fit 1k resistor between filter and RX3 transformer.

Shogun - LED bar driver LB1415 can be replaced by LB1405.

Icom ICB1050 varies its RF gain as you use the squelch. This is due, helpfully, to a diode not shown on the circuit diagram! Luckily it is the only diode underneath the circuit board, so cut it out if you don't want this "racility".

- has a tendency to go "deaf" because T101 goes open-circuit. Replace this transformer with TOKO 113CN2K159DZ from "Cirkit".

Bremi BRL210 linears are potentially LETHAL because the mains earth goes to a 1" wide by 5" long strip of PCB. The PCB cracks at the supporting bolt and leaves the case unearthed. Drill the case, scrape away the paint and secure a good earth with a solder tag and bolt.

B30 Linears - Low TX can be caused by poor earth between case and PCB.

Bremi BRS31 PSU 2200uF capacitors dry out causing low voltage output on-load.

Quasar CB - Switching transistor (2SC1815) behind mic socket goes s/c causing low audio hiss on RX with TX light remaining on.

Radiomobile 202 - PLL not locking - replace D2 (6v2 zener).  
- Low audio - replace Q15 (2SA733).

Communicators, Manor Kestrel, Planet, Serpent - Stuck on TX - Q22 s/c, replace with TIS91.

- No RX and TX stays on when keyed - check D13 near relay.

LCL/DNT 2740 - relay dropping out - replace Q11.

LCL ECONOMY 40FM:- Small resistor in series with voltage supply track to LC7137 pin 18 burns out. Replace with 270R. Mixer coil adjuster can apparently screw itself in causing loss of receive. (Coil is towards rear and has small adjuster).

Binatone Speedway - Low audio, poor sensitivity on RX, low power on TX - replace Q18.

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Harvard/Alba 40 Ch handset - no Freq. mod. although the carrier is perfect and the Roger Bleep may just be audible. Locate the diode (D20) closest to the HI-LO power switch. This diode is under-rated and should be replaced with a 1 Amp type such as 1N4001.

HARRIER CBX HQ has only two-core mains cable. Always fit 3 core cable, for safety!

Pegasus 7: Change C184 to 2n2, R155 to 2K2 to improve echo.

Colt 444s and Ham International FM rigs et alia: no TX at all. Locate and replace the black diode, in front of the modulation transformer, with a 3 Amp type.

- crystal filter- remove ceramic filter and the 220 Ohm resistor connected to it. Fit a 1k5 resistor and crystal filter instead. No retuning necessary.

Murphy CB1500H home base rig - low power o/p on TX can be caused by burnt out L7 (27uH). You can rewind this yourself, if necessary, with 68 turns of 30SWG enamelled copper wire. (The plastic cover can be cut away and discarded.)

Grandstand Hawk, Lowe TX40

Replace C65 (3pF) with the crystal filter. Retune L16 and L17.

Falcon, Compact 40 - T1 can be replaced with a Toko 113KN2K241DC.

DM315E microphone using DM432 board - two unsoldered tags on slide cause hum. Solder them to 0v.

HAM RELAX hand power mike. This mike is normally very bassy and sounds muffled on most rigs. The following mod can be used on other battery-powered mikes, too. Remove old mike insert and fit Tandy electret mike (270-092B), cushioning it in foam rubber. Connect screen to 0v ground. If a resistor is used between original insert and PCB, remove it. Connect inner core of Tandy insert to the PCB via a 10uF tantalum capacitor. Connect the +ve lead from the Tandy insert to battery +ve (VCC). On the Ham Relax mike, remove the top-cut capacitor from between the F.E.T. and the volume control slider on the component side of the board. Volume control housing can cause hum. Solder its tags to -ve rail to eliminate hum.

Altai power/echo mikes - Echo disappears when battery voltage drops.

Sirtel 2002 and 313P microphone - the mike clip screw on the back can be overtightened to cause a short which results in intermittent speech. Fit a "sticky fixer" under screw base.

Realistic Noise Cancelling Mike - the switch can return too far and mute the audio. Build up the inner case or the trigger with hot glue.



"INVISIBLE" Aerial.

As sunspot activity gradually increases and with the introduction of the Novice licence in the USA the 10 metre band will become increasingly active. In a couple of years (or less) when the voices of those bright young Novices start to boom across the Atlantic (O.K. Who said "one four for a copy"? ) we shall all be wishing we'd invested in a decent aerial with low angle radiation pattern. So why not do something about it now. AND make the neighbours think we've finally given up this "silly" hobby for the well-known delights of "Eastenders" and "Dallas"?

A high efficiency short aerial for homebase use can be made from an ordinary TV aerial and a six foot aluminium TV pole. The aerial is mounted centrally at the top of the pole which is capped to prevent ingress of rainwater. A two foot length of 7/8" fibreglass rod is pushed into the bottom end of the pole, leaving 10" protruding, and a hole drilled through the two, one inch from the end of the pole, so they can be secured with a 35mm brass bolt. A 700mm length of 75 Ohm TV coax is connected to the brass bolt with the inner conductor shorted to the outer braid at each end. This aerial combination can then be mounted in a convenient location, such as a gable end, with the insulating fibreglass rod clamped to a steel bracket. The coax may be longer than 700mm, if necessary, but the effective length of coax plus rod must be less than 1/2 wavelength. The nominal dimensions are approximate so the following procedure must be adopted:-

Take another piece of 75 Ohm coax, greater than 2100mm in length. Pass the "700mm" coax through the gable end wall into the loft and connect it to the inner conductor of the "2100mm" coax. To the adjacent braid of the "2100mm" coax connect at least three lengths of coax, each 1/4 wavelength long, shorted at each end. (any thick copper wire will do, instead.) Spread these ground plane wires out and downwards at about 30 degrees to the horizontal. Wooden blocks with brass screws and washers were used to make connections in the original so there's no need to spend a fortune! To the other end of the "2100mm" coax connect an SWR meter via a VERY short 50 ohm patch lead. Use low power transmission near the band centre, ensuring that the frequency is not in use and giving your callsign occasionally. Shorten the "2100mm" coax inch by inch until the lowest SWR reading is obtained. If you cut off too much, the readings will start to rise and you will need a new piece of coax! (By the way: for those youngsters who have never dealt with inches, there are 25.4 mm to the inch. I'm sorry to mix my units, but I'm an old engineer).

The SWR should be lower than 10:1 but will almost certainly be well into the red. Connect a 1000mm stub of 75 Ohm coax to the inner and braid (individually) of the "2100mm" section at its junction with the 50 Ohm lead from the SWR meter. Stick a pin through the open end to short inner to braid (my wife complained because the baby's nappy fell off). Move the shorting pin progressively closer to the joint until the lowest SWR is obtained at the centre frequency of the band required. The reading should be no worse than 1.2 : 1. When the correct lengths have been found, replace the temporary joints with a "T" piece and plugs, if desired, and cut and solder the stub inner and outer together at the pinpointed spot (ouch!)

The dimensions in the sketch are for a band centre frequency of 27.2 MHz as the aerial was originally designed as a disguised antenna for the (then illegal) CB band, but has a fairly wide bandwidth and is eminently suitable for the Amateur 10m band.

Explanation: The aluminium pole acts as the actual aerial with the TV aerial on top forming a capacitance hat which, in theory, effectively raises the point of maximum radiation (lowering the angle of radiation). The 75 Ohm

coax connected to the pole is an extension of the radiating element. It should be kept vertical (in so far as is possible since it passes through the wall!) and must not go through any part of the bracket, nor sit close to a metallic structure. The "2100mm" length is an impedance matching transformer. (The impedance of the aerial is far greater than 50 Ohms, giving good efficiency but poor matching). It is important that good quality, semi-air-spaced, 75 Ohm TV coax is used for this section and for the shorted stub. This stub acts as an inductor to "cancel" the capacitive reactance of the aerial. (If the aerial were effectively longer than  $1/2$  wavelength, the stub would need to be open, not shorted.)

Installation: The aerial was specifically designed to be mounted on a gable end, although chimney mounting is possible if the ground plane and matching sections of coax can be positioned satisfactorily and weatherproofed. The aerial should be several yards away from any metal structure such as a TV aerial, water pipe, drainpipe or stainless chimney liner. The system has, however, been used very successfully on a caravan, with the ground plane taped across the roof and the aerial mounted on a wooden mast lashed to one corner of the caravan. The coaxial down-run is 50 Ohm coax and must be kept away from mains wiring and your TV aerial coax or that of your neighbour. Several installations have been made and no problems have been experienced. Note that the aerial is NOT significantly directional, although a slight bias in the direction of the groundplanes may be noticed.

Bastion Glassfibre at 44 Hutton Close, Crowther Industrial Estate, District 3, Washington, Tyne and Wear, supplied the  $7/8$ " glassfibre rod which they sold quite cheaply as a scrap starting-end. It is extremely strong, being made by a process called "Pultrusion". For extra weather resistance it should be given a coat of boat varnish. Contact Bastion Glassfibre on 091-4166394.

I have known amateurs stick  $5/8$  wave aerials up plastic drainpipes (interesting effect when it rains), coil wire around washing lines (green stripes on the baby's nappies!) and use a cricket ball to throw an "invisible" wire over the rooftop (O.K. I admit it was I who smashed the greenhouse). All these aerials have distinct disadvantages which, curiously, were not obvious when they were first considered!

THIS aerial is TRULY invisible. Neighbours have stared fixedly at mine and asked "Which Amateur Radio aerial. I can't see one". (My real TV aerial is in the loft, by the way - but I haven't told the neighbours!)

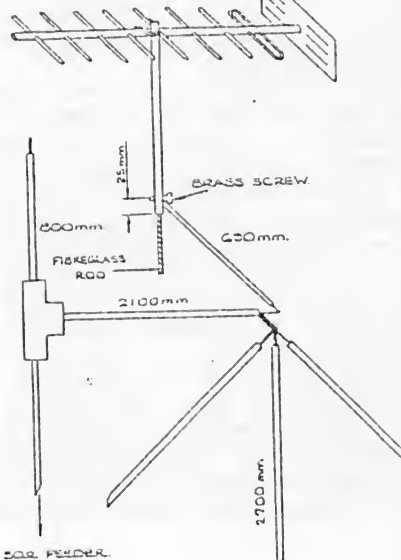


Fig. 8

### S Meter Preamp

The S meter preamp was designed specifically for the Uniden/Audioline range of rigs which suffer from "a lazy needle". The LM358 op amp is used because it is able to work from a single-rail supply. Silicon diodes are used in the feedback path to give a logarithmic response which more closely approaches the response required for a true S meter. The 4k7 resistor sets the overall gain of the circuit at low signal levels.

When the circuit is used in the Audioline, the meter connections must be reversed as the output from the amplifier is positive-going. D5 must be reversed so that power output can still be read. RT1 must be disconnected from RT3 and from the meter and the free end wired to the -ve input of the amplifier. The output from the amplifier is connected to the S meter +ve terminal via a 47k preset. RT1 and this preset can then be juggled to give the optimum setting on received signals, bearing in mind that the aerial efficiency will have a big influence on the final settings. Although the two adjustments are interdependent, RT1 determines the low-level signal readings, and the 47k preset determines the high-level readings.

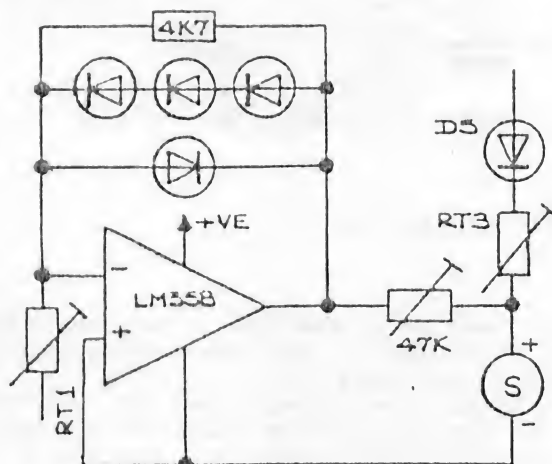


Fig.9 Uniden "S" meter Amp

### R.F. Preamp

The R.F. Preamp was designed for general use in CB radios but, so far, has been used only in Audioline/Uniden rigs. The circuit may be built on veroboard but connections should be kept short and unused sections of track be disconnected to avoid a build up of capacitance. VR1 may be any value, but R1 should be changed accordingly to maintain the same ratio. R3 is essential to lower the "Q" of the circuit and prevent oscillation. The supply to R4 should be taken from the RX supply rail which comes from TR17 emitter.

Disconnect C4 from the transformer L1 in the Audioline. Connect G1 of the preamp to the junction of C1 and L1 in the rig. Connect D of the preamp FET to the free end of C4 in the rig. Adjust the inductor of the preamp for maximum mid-band signal.

In the Audioline, the "preamp" was found most useful as a means



## Midnight Express

of decreasing, rather than increasing, the signal in order to reduce "bleedover" (where this rig already scores highly).

The squelch control was replaced with a dual ganged control from a scrap rig.

With a little ingenuity this preamp should work in most rigs. (Who's going to be first to try it in a Cobra 148 ?)

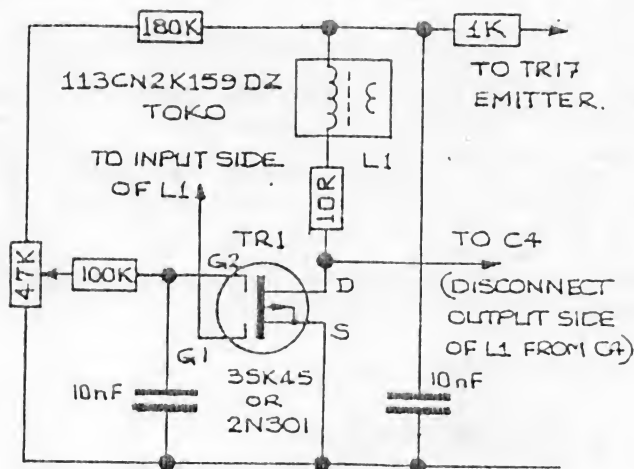


Fig.10 R.F. Pre-amp for Uniden rigs

## Superstar 2000

The Superstar 2000 (and a few new rigs) has four banks of fifty channels going down to 25.965MHz. As an interesting exercise you might like to make the following modification:

Remove the wires from the tone switch and connect them together, as appropriate. Cut the two tracks as shown. Add the two 10k resistors and wire to the tone switch as indicated. Now see where it gets you! (You may need to change D1 (5v6) to 6v2 for full swing of the VCO, which will need slight retuning, by the way.

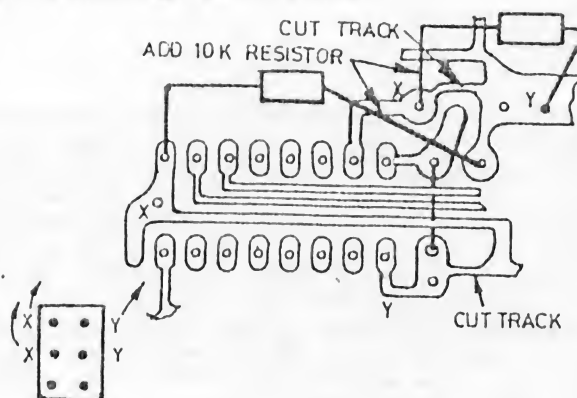


Fig.11 Superstar 2000

Roger Bleeps

The first two circuits are very similar and use a 556 dual timer IC to produce both the bleep tone and the transmit delay function. The use of the trigger and reset pins together is an unusual feature which is used to remove the need for an extra transistor inversion stage. The use of the IC in this way has an unfortunate side effect of making it very critical of supply voltage, consequently you may need to alter the number of diodes on the 13v line in order to maintain the 556 supply at 11v to 12.5v.

The first circuit (Fig.12) uses a miniature 12v relay for TX/RX switching, whilst the second version (Fig.13) uses a bipolar transistor and Vmos FET combination. This version is slightly cheaper but has the drawback that on some rigs (notably Cybernet 134 board) the bleep will be heard through the speaker. Some people like that.

Both versions require the TX input from the mic socket to go directly to the bleep circuit which provides a corresponding TX output for the rig. The RX input from the mic socket is not used in the relay version. In the second circuit the RX input is taken to the bleep board which provides an RX output to the rig. In both circuits the audio output from the bleep board is connected to the mic input wire on the socket. I think the diagrams make all this clear.

To switch the bleep off, by the way, disconnect the 10uF delay capacitor.

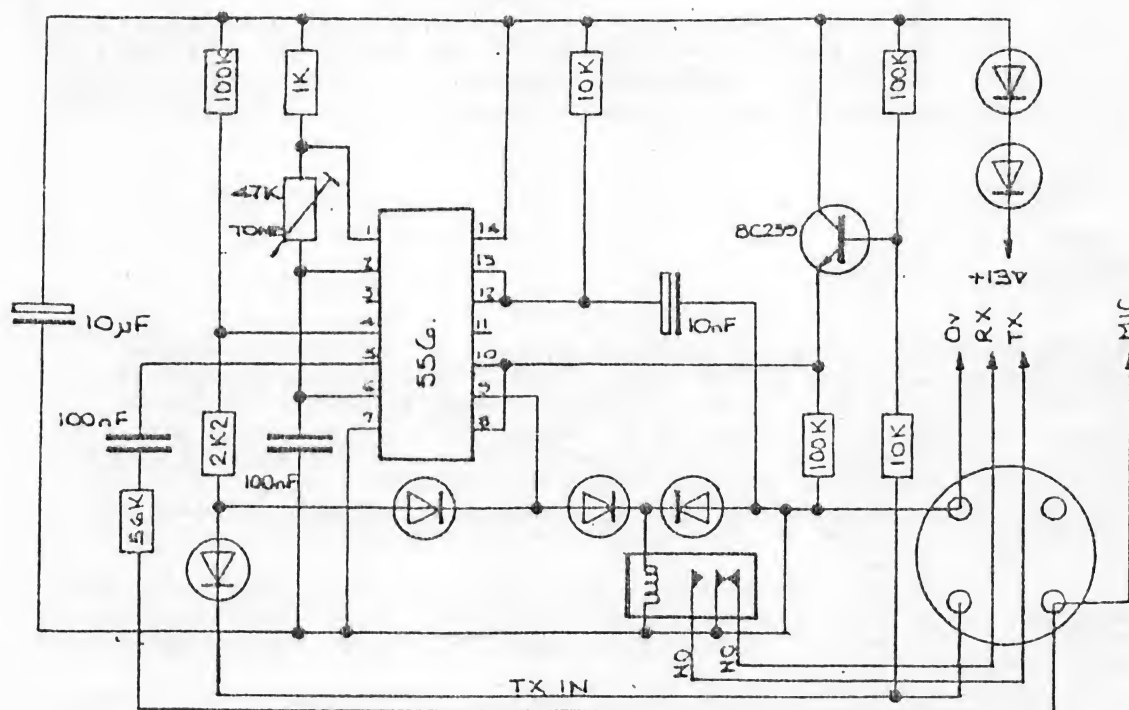
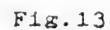


Fig. 12



IC2 is a quad two-input NOR IC which performs delay functions, gating functions and produces the bleep tone which is adjusted by VR3. VR2 determines the speed and VR1 the output (volume). A VN10KM Vmos FET is used to "pull" the TX line low during the bleep function. This circuit is susceptible to interference from high levels of RF radiation and should be suitably screened or kept away from the transmitter output.



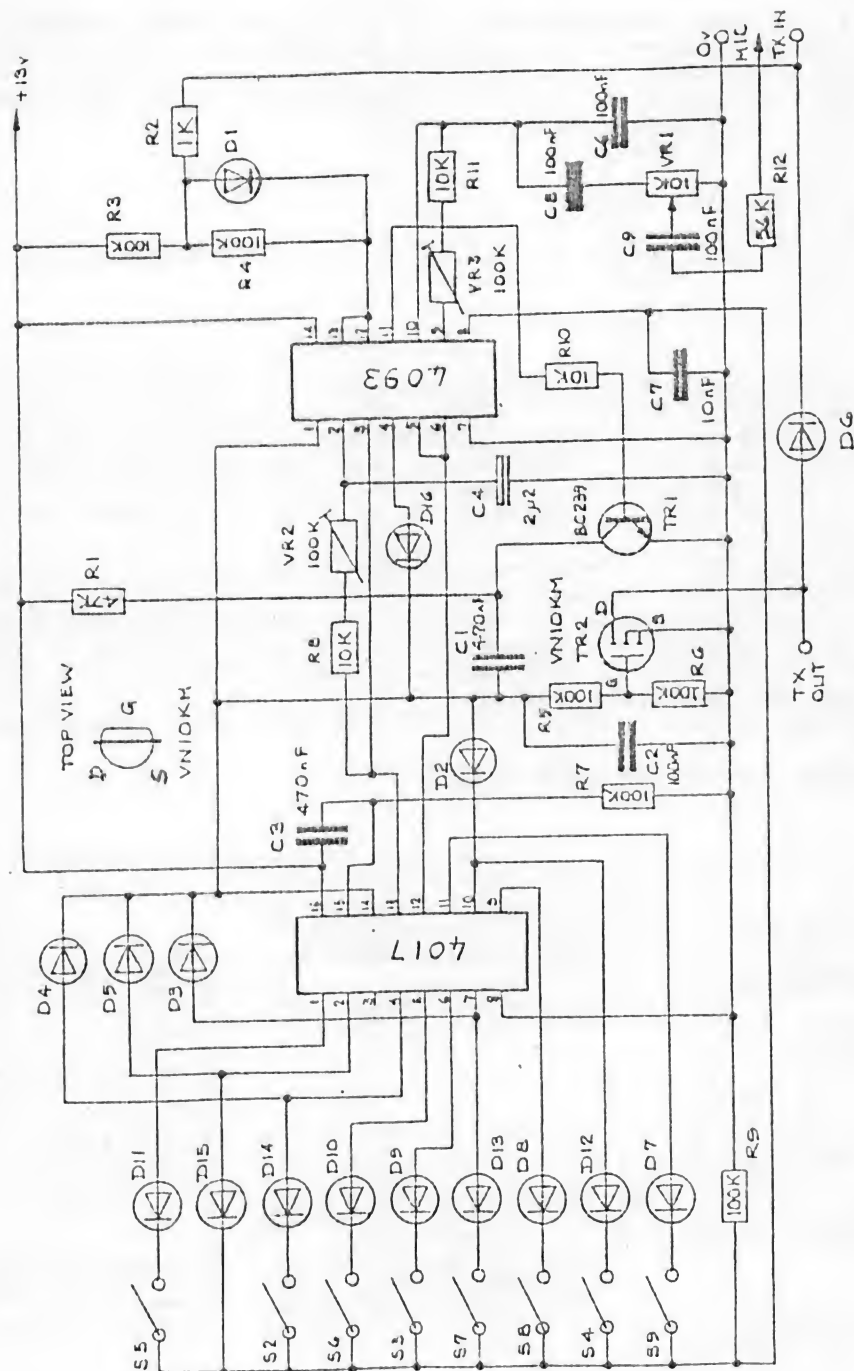


Fig. 14

MC145151 Synthesizer

This Low-Power complementary MOS device is a very versatile IC indeed. It has fourteen input data lines (pins 11 to 25) giving it the capability of dividing by any figure between 3 and 16383. It also has 8 selectable dividers for the reference crystal which are programmed by the levels on three pins as follows:-

pin-7	6	5	divide by
0	0	0	8
0	0	1	128
0	1	0	256
0	1	1	512
1	0	0	1024
1	0	1	2048
1	1	0	2410
1	1	1	8192

The most remarkable feature of this IC is its ability to work directly with frequencies in excess of 30MHz. Typical current drain is less than 2mA at the maximum supply voltage of 9v. The TX/RX pin 21 produces an offset of 856 when it is held low, but this offset is of no use in CB applications. A reference crystal can be connected between pins 26 and 27, obviating the need for a separate crystal oscillator circuit.

Note that this IC requires more than half its rail voltage on an input before it will recognise a logic "1". If an Eprom is used on a 5v supply the output will not be more than about 3.5v. The MC145151 supply can't, therefore, be much over 6v if the input is to "see" a logic "1" from the Eprom. The supply voltage needs to be as near to its maximum as possible, however:

- to achieve maximum swing of the "PD" output (and, therefore, of the VCO) and
- to operate at its maximum frequency.

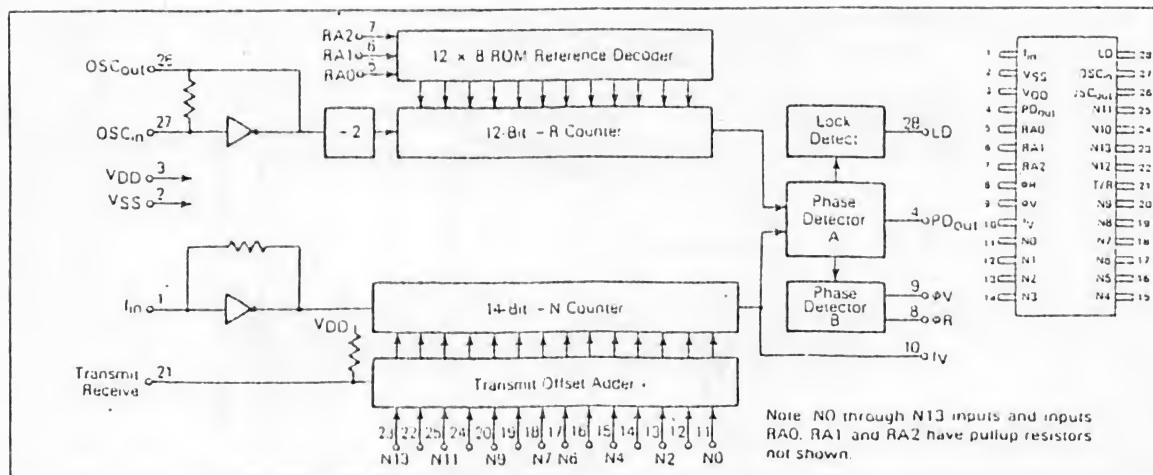


Fig.15

### Reftec Circuit Explanation

Fig.16 shows the circuit of the early Reftec rig. Starting at the heart of the circuit, Q17 and associated components form the VCO which oscillates at around 470 MHz. This frequency is controlled by the PLL IC which is an MC145151P. If you refer to the January issue, page 14, you will understand its operation more easily. Pins 5, 6 and 7 determine that the 6.4 MHz crystal frequency is divided by 256 to give an internal reference frequency of 25 kHz. This is chosen because the channel spacing is 50 kHz. The later version leaves pin 5 high to divide by 512 and the resultant reference frequency of 12.5 kHz gives 25kHz channel spacing. A 40 position channel switch is used and feeds pin 16, as well as pins 15 to 11.

Q32 forms the heart of a crystal oscillator which is used to produce the downmix frequency by giving the harmonic of a 73.834375 MHz crystal. During TX on channel one, therefore, the oscillator sends 147.66875 MHz through the tripler stage Q31 to give 443.00625 MHz at the mixer Q30.

The VCO output is amplified and buffered via Q18, Q19 and Q29 whence it goes to Q30 to be mixed with the downmix frequency. The difference is amplified and buffered by Q28 and Q27 to reach pin 1 of the MC145151P.

Now channel 1 selects the binary inputs as 00001111000000 which is 960 in decimal.  $960 \times 25 = 24000$  kHz so this represents the difference frequency for channel 1. The VCO, therefore, is running at  $443.00625 + 24 = 467.00625$  MHz. This frequency leaves Q19 to be amplified by Q22 and doubled by Q23 so that the frequency which reaches output driver Q24 is 934.0125 MHz. (The doubling action ensures a channel spacing of 50 kHz, as the VCO moves in 25 kHz steps.) Note Q20 which monitors the lock-detect output (pin 28) and turns Q21 on only when the VCO frequency has been stabilised. The associated LED gives a visual indication.

During receive, a 72.051042 MHz crystal is selected by forward biasing its series diode. The associated varactor diode is supplied by the audio output of the I.F. demodulator IC to control the effective deviation on RX. On channel one Q32 passes the 144.10208 frequency through tripler Q31 to feed mixer Q30 with 432.30625 MHz. The VCO runs 24 MHz higher at 456.30625 MHz which is doubled and 912.6125 fed to Q2, the first mixer. ( $934.0125 - 912.6125 = 21.4$  MHz which is the first I.F.) The received frequency mixed down to 21.4 MHz is amplified by Q3 and fed to the MC3357 IC which mixes it with the 20.945 MHz crystal output to produce 455kHz, the second I.F. The final demodulated output is passed to the volume control and via one of the four op. amps to the LM380 audio output IC. The 455kHz output is also fed to Q8/Q9 amplifier which supplies the diode-pump "voltage doubler" to give a signal amplitude indication by lighting the LEDs. The arrangement of Q10, Q16 and the diode ensures an approximately logarithmic response.

The microphone input is amplified by an LM324 quad op. amp. which includes filtering and limiting circuitry. Deviation is set by a preset across pins 6 and 7 with the output from pin seven being filtered and passed to the varactor diode in the VCO circuit. Q6 provides a regulated supply of just over 9 volts for the LM324; Q7 performs the same function for the VCO; Q4 and Q5 provide 9 volts for the RF input and I.F. stages, respectively, and Q26 supplies the MC145151P and the crystal oscillator, buffers and mixer. The whole circuit could, in theory, be served by a single regulator but, presumably in practice, the use of five separate transistors eliminates the risk of interreaction. Q26, by the way, has a habit of going short circuit and taking the MC145151P with it (at least £16 to replace !). You would be well advised to fit a 1 Amp transistor BEFORE Q26 blows.





### Uniden "Xtra 20" board

A simple conversion for Audioline and similar rigs to give another 20 channels immediately below the UK channels.

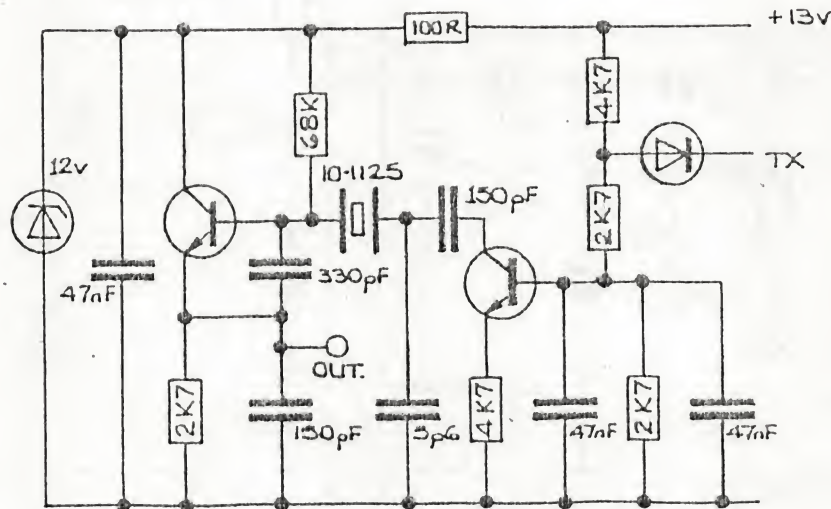
The 20 channel board comprises a simple crystal oscillator plus a transistor switch to shift the crystal frequency on transmit. The shift is necessary to compensate for the mismatch which occurs between TX and RX when a frequency other than 10.24MHz is used as the PLL reference input. Even so, we can't move very far from 10.24 or the difference becomes so great that only one or two useable channels would be produced.

The crystal used was a physically large 10.1125MHz device obtained from Birketts. Other crystals of around this frequency can be used. The two capacitor values which determine the exact TX and RX frequencies (nominally 5pF and 150pF) are critical and will need adjustment for optimum results.

Once the board has been built up it may be fitted as follows:- Disconnect the tracks from the tone switch and determine which contact is which (hint- the slider contact is not in the middle). Locate C55 (22p) next to IC2 and disconnect it from TR14. Reconnect it to the switch slider. Connect the emitter of TR14 to one of the remaining switch contacts. Check that the rig works normally with the switch in one of its two positions.

Connect the "Xtra" board output to the remaining switch contact. Connect +ve and 0v and wire the TX input to D13 cathode (just behind the speaker clearance area). All that remains is to tune the "Xtra" frequencies to match the TX/RX frequencies of another rig with the identical modification. Alternatively the Uniden can be matched up with a rig on HI band.

A similar modification can be done on 134 chassis rigs, but instead of switching a capacitor, you will have to switch two alternative crystals (I used TX-10.1625, RX-10.1137) as the shift required is far too great to achieve with a capacitor. You will also have to fit a separate 10.24 oscillator to feed the first IF mixer stage.



UNIDEN "XTRA" 20 BOARD.

Fig. 17



Ham VCO Block

The green or orange coloured VCO block used in Ham International rigs is a source of many sorrows. The usual problem is that a "screwdriver expert" will destroy the special low-permeability core. Low-perm. replacement screwcores are available (but at a price). If it is replaced with a screwcore from another type of VCO coil, the chances are that the VCO will no longer cover the full range of frequencies.

If this is the case, or if you need to broadband the VCO for other reasons then read on. The VCO block comprises a small PCB potted in resin, clad in steel and housed in a moulded plastic cover. If the latter are removed you will be left with a clear block with five pins protruding. Near one corner you should be able to see a small disc ceramic capacitor of 22pF. To broaden the coverage of the VCO you must use a miniature electric drill carefully to grind away the resin which encloses this capacitor. Replace it with a 15pF ceramic capacitor and reassemble the VCO block.

The sketches, below, show the underside view of the block and its circuit, together with the connections to the TA7130 balanced mixer IC with which the block is used.

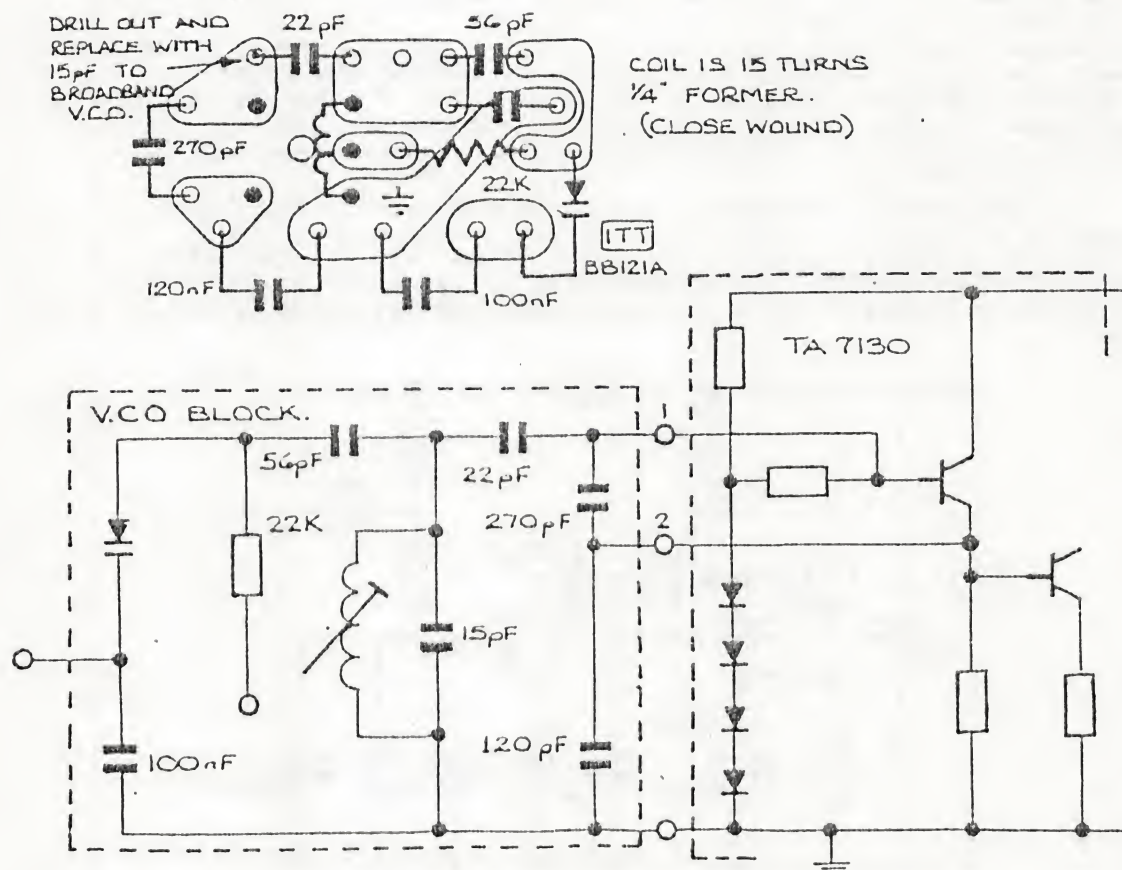


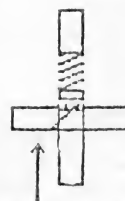
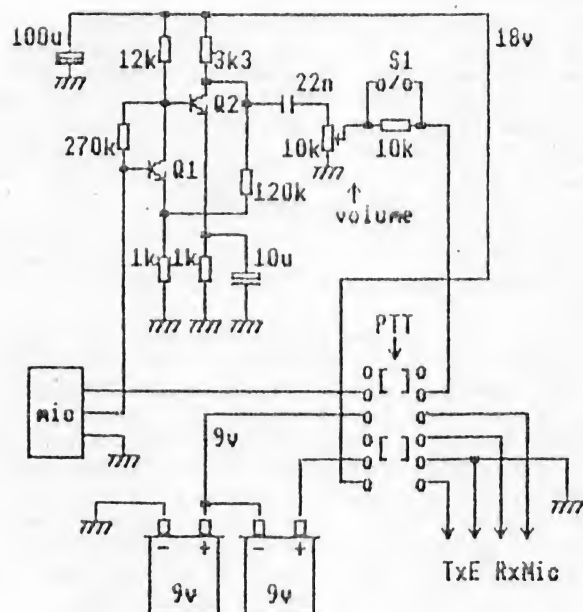
Fig. 18



### Base Mike

The circuit of the base microphone is shown below. The components may be assembled on tagstrip or Veroboard which must be mounted in a metal box (for screening purposes). The prototype used a standard microphone curly cord to connect to the rig with volume control and PTT switch on top of the box. The Tandy mike insert was fitted in the end of a car map-reading light "bendy" stem using foam rubber to isolate it from the metal (otherwise it sounds terrible). Proper "bendy" goosenecks and foam wind covers are available from suppliers such as Industrocom in Bradford. Switch S1 alters the tone and volume on some rigs.

(I am grateful to David Cramp for contributing this article. I have removed a couple of unnecessary capacitors but otherwise left the circuit unchanged. I believe, however, that it will work perfectly well on 9v instead of 18v, since only about 20mV is required by the rig ! There is plenty of scope for experiment, but the circuit, as described, will work perfectly well.)



unhook link and move to one side. Do NOT remove the link from the top. The switch will no longer have a latching action.  
Tandy part No. 275-9402

Mic element Tandy part No.

270-092B

Q1 - BC109 Q2 - BC108

Fig.19

Broadbanding of RF stages on sets using PTBM0590CY board is sometimes needed when fitting extra channels. Adjustment is made easier by the following modification:

Locate T4 near the mic socket and look at the copper tracks. This coil has 5 pins: 1 goes to 0v, 2 not used, 3 not used, 4 goes to pin 9 of IC3 and 5 goes to C90 and to a resistor. Simply cut the track to pin 4 and join the track to pin 3, leaving pin 4 disconnected. Retune T4.

### Sidebands Explained

AM/FM transmission is easy to understand. For example, look at Fig.20 where the output frequency is created by mixing the VCO frequency 17.555 (determined by the channel selector) with the downmix crystal frequency 20.105 (determined by the bandswitch) and then subtracting the 10.695 crystal frequency from the result to give 27.965.

Now look at Fig.21 for upper sideband transmission. Here, the 10.695 crystal frequency is mixed with the voice frequency (say 3kHz) to produce  $10.695 + 0.003$  and  $10.695 - 0.003$ . The two results are fed to the crystal filter which allows through only 10.692. This is subtracted from 37.660 to leave 26.968 - the upper sideband frequency. In Fig.22 all the input frequencies are lowered by switching trimmer caps across the crystals. The voice frequency is now mixed with 10.692 to produce 10.689 and 10.695. The crystal filter allows only 10.695 through and this is subtracted from 37.657 to produce 27.962 - the lower sideband frequency.

You should have followed this simplified explanation, so let's look at Fig.21 in more detail. The balanced modulator is a clever I.C. The voice frequency not only "mixes" with the 10.695 intermediate carrier; it also modulates the amplitude. That is to say it forms an envelope around the carrier frequency as in Fig.23.

Forget frequencies for the present and consider amplitudes, instead. As the voice sine-wave wobbles up and down 3000 times per second, so the amplitude of the intermediate carrier also wobbles. In addition, if the voice is loud or soft, the overall amplitude of the intermediate carrier is high or low. You will appreciate, therefore, that if the voice amplitude falls to zero, so the intermediate carrier disappears. The balanced modulator acts as a gate and allows the carrier through, only when some voice signal is present. If the intermediate carrier is not available to mix with the 37 MHz signal there will be no TX output (since 37 MHz is well outside the range of the 27 MHz output filter coils). Thus, the amplitude of the voice governs the TX amplitude.

As we noted, at the beginning, the voice frequency affects the intermediate carrier (and therefore the TX) frequency. The frequency can't alter by more than 3 kHz or neither result will pass through the crystal filter (Fig.23). In practice, the audio input is filtered before it reaches the balanced modulator to ensure that there are no frequencies above 3 kHz which could cause intermodulation products ("Spurii") in the output. In addition, a feedback circuit (ALC) on the audio amplifier also limits the maximum amplitude to avoid similar problems. Next, there is a feedback circuit (AGC) in the RF output stages to limit maximum power output. Excessive amplitude in the AF or RF stages can cause "clipping" of the waveform which generates unwanted harmonics.

Finally, the balanced modulator provides another most important function. Normally, when two frequencies are mixed, the output comprises the sum, the difference AND the original frequencies. The result of mixing, say, 3 kHz with 10.695 would, therefore be 10.692, 10.698, 10.695 and 0.003 MHz. Clearly, the filter will stop the 0.003 but it will not stop the unwanted 10.695 "carrier". The circuit in the balanced modulator is designed, therefore, to take part of the 10.695 input and invert it (180 out of phase) then mix it with the output. Two trimmers are provided to match the amplitudes of the out of phase components so that they cancel out completely. If this were not done, an unwanted carrier would be transmitted.

For reception of sideband signals, exactly the same oscillator frequencies are used. The 37 MHz frequency is mixed with

the incoming signal to produce a frequency within the crystal filter pass band which is used to modulate the intermediate carrier frequency. The carrier which was originally removed is, thus, re-inserted. A normal amplitude modulated carrier results which can be demodulated in the normal way. In practice it is demodulated directly, without conversion to 455 kHz since no further selectivity is needed.

A properly adjusted SSB signal uses little more than 3 kHz band space. No power is wasted in transmitting an unnecessary carrier, consequently the RF output stage can be driven harder without overheating. It is an efficient method of transmission and the narrow bandwidth permits the use of 2 channels for every one of AM or FM. It also reduces the amount of interference picked up. Drawbacks are the very critical frequency settings required and the degradation of audio quality caused by narrow bandwidth and carrier re-insertion.

You will notice, by the way, that if there is any carrier remaining in the transmission, then the receiver will hear a beat note or low howling sound which makes it difficult to make out the speech. A similar whistle is caused by another transmission with a carrier (AM or FM) on a nearby frequency. You can tell just how near by the frequency of the whistle. It is possible to read a SSB signal on an AM receiver if an adjustable oscillator is used to re-insert a carrier, before demodulation.

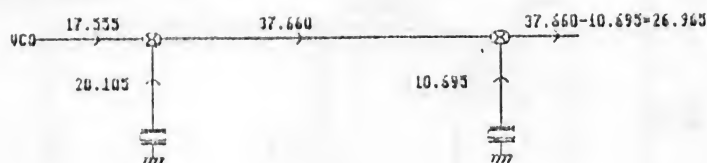


Fig. 20

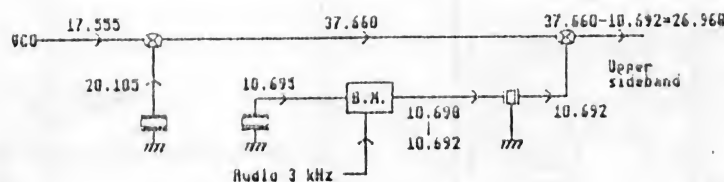


Fig. 21

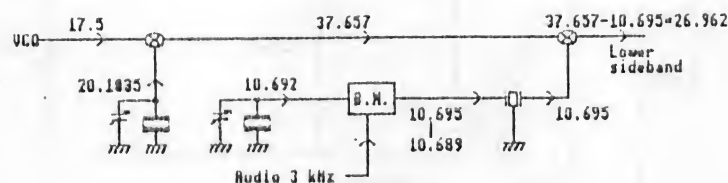


Fig. 22

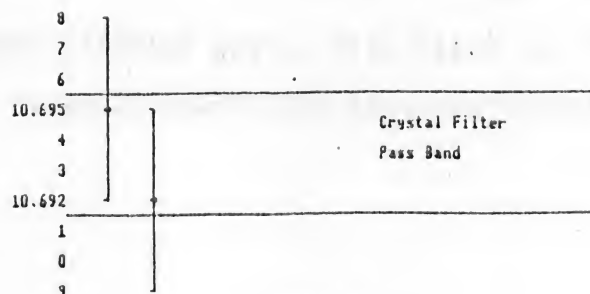


Fig. 23

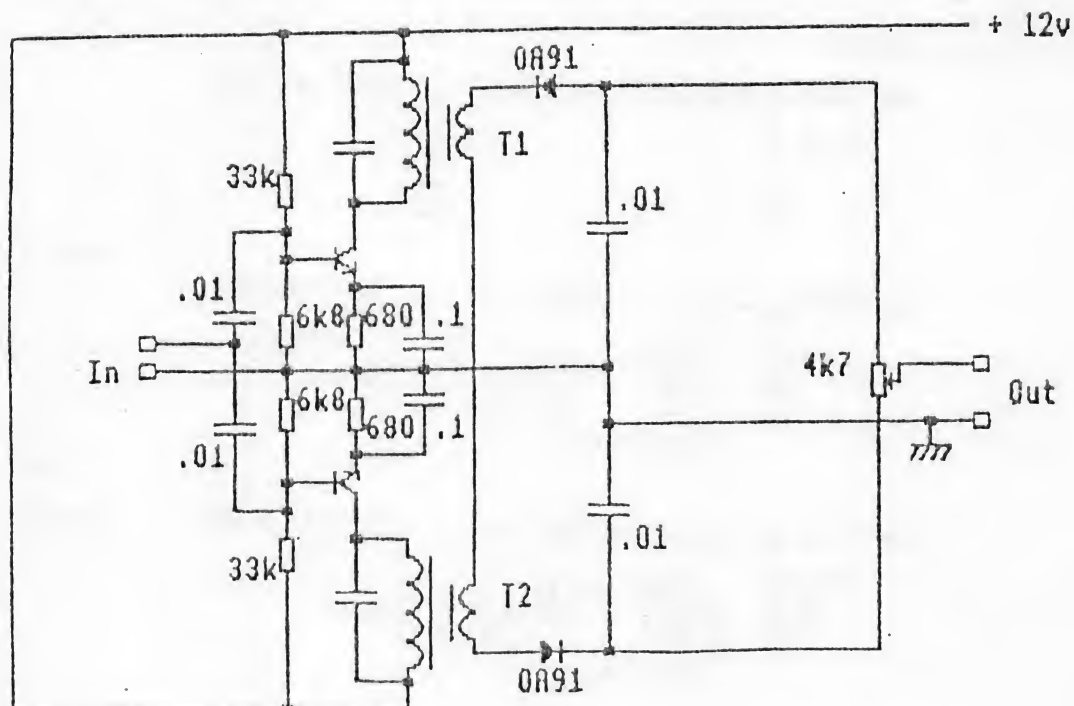


### Travis type FM Discriminator

The circuit consists of two detectors fed in parallel, with outputs combined out of phase across a common load. Both tuned circuits are initially aligned to the I.F. centre frequency, then one is tuned above and the other below the centre frequency to produce the desired "S" shaped discriminator curve. RV1 balances out residual AM response. Connect a high impedance centre-zero meter here for tuning purposes. Use low impedance secondary I.F. transformers. Limiting can be achieved by adjusting the transistor base bias.

#### Advantages:

- a) Works with any Intermediate Frequency.
- b) No special transformer needed.
- c) Operates with FETs or bipolar transistors.
- d) No limiter required.



Transistors BC108 (or AF117 with supply polarity reversed)

T1 : T2 any IF transformer used with transistorised circuitry

Fig. 24

JOTTINGS on the PTBM121D4X

This board is found in a number of multimodes, including the Hy-Gain V and the Concorde II (Fig.25). Some variation in the front panel controls and crystals is to be expected. In particular, whilst the two rigs mentioned use 20.555 (HI HI), 20.330 (HI), 20.105 (FCC) or 19.88 (Midn) crystals, other rigs use a frequency doubler circuit with crystals exactly half these values.

One well known problem is poor transmitted audio on UK frequencies caused by lack of tune range. A simple fix is to retune the relevant crystal(s) on the PTOS011AOX (padding with extra capacitor may be needed).

Common faults include the AVR going open circuit (rig lights but no TX/RX) or short circuit (very odd effects like no TX on FM but needle hard over on SSB with accompanying whistle); channel switch goes faulty - the ratchet wheel becomes loose on the spindle. Sometimes it can be degreased and glued with araldite. The Darlington transistor can go o/c resulting in no power output on AM or s/c resulting in no modulation (but FM/SSB O.K.). You must replace with the correct type or use two NPN transistors to form a Darlington pair. (If you don't know what that is, read a few electronics magazines!).

Q39 and Q40 form a TX/RX switching pair. Any fault here can cause odd effects, usually with TX/RX functions mixed up, for example TX light on during RX and only a weak hiss from speaker.

By far the most common faults, unfortunately, are caused by people fiddling with adjustments. Very few adjustments can be made satisfactorily without the aid of the proper equipment. I advise you to follow the Service Manual to the letter, especially when dealing with SSB adjustments. The only one you can do, easily, is the RV5/RV6 carrier null adjustment where you key the mike on SSB and adjust until no reading is obtained on the power meter (with mic gain on zero).

If you turn the AM bias adjuster you will increase the power output slightly on AM. You will, however, reduce the modulation. With a scope, the setting is simple; without a scope you can only adjust it for the loudest reported modulation on TX and cross your fingers. You will probably read about 2/3 the power on AM compared with FM when the adjustment is somewhere near.

If transmitted power is uneven across the frequency bands, adjust the coils as follows: the two marked TXLO for maximum power on the very channel 1 LO band; the two marked TXHI on channel 40 (perhaps 80) on HI band and the remaining TX coils on channel 20 (60) on the Mid band. Repeat the procedure as many times as necessary to achieve an even power spread.

Should you need to adjust the VCO, make a proper square adjustment tool or you will break the screw core.

The RF transistors are simple to remove if you desolder the leads and remove the complete aluminium heatsink with the transistor still attached.

Fig.25 on the next page should help you to find the major items.

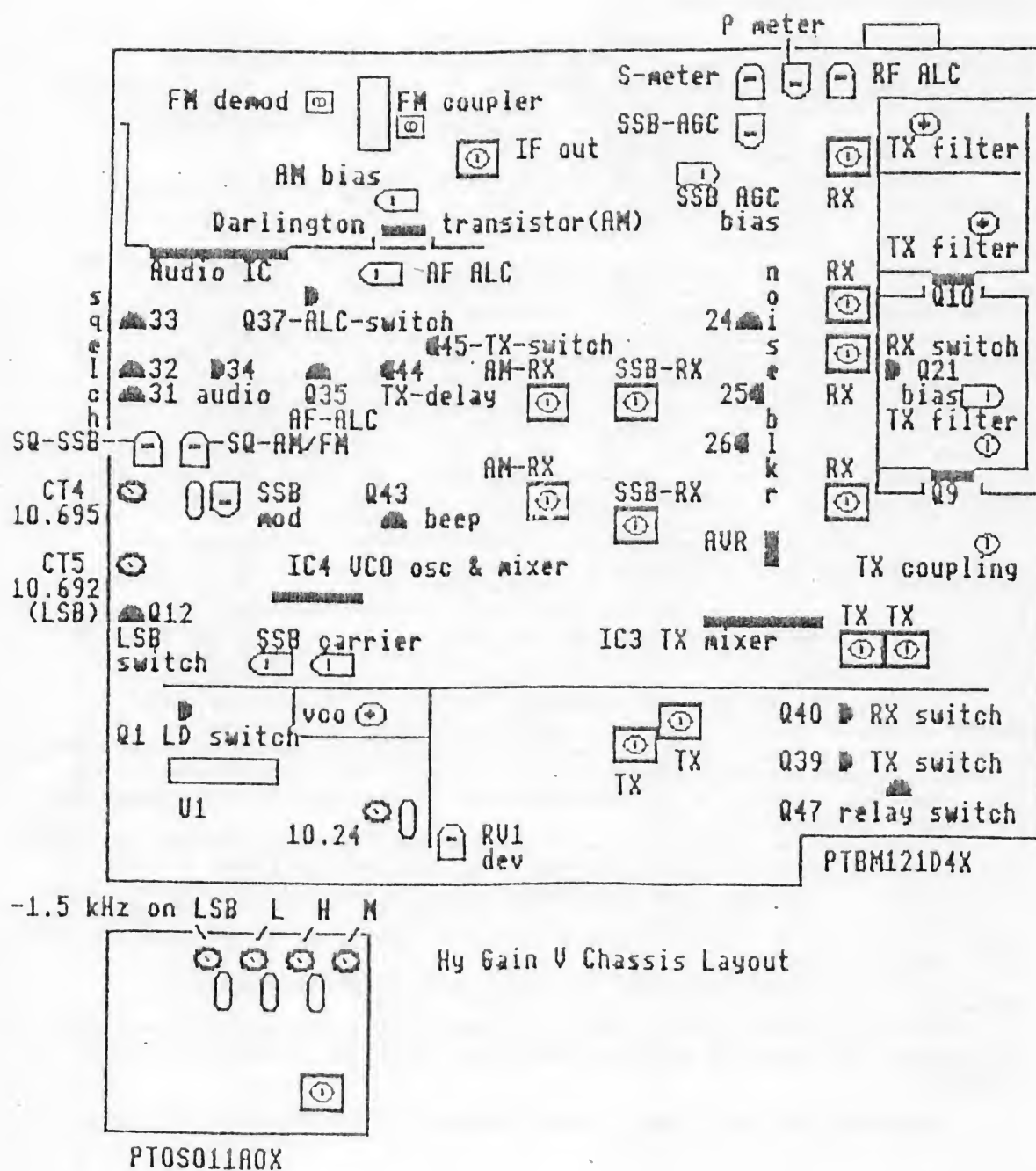


Fig. 25

### DNT Circuit Description

Fig.27 shows the circuit of the DNT (also Radiotechnic RT852) rig and the component layout is shown in Fig.26.

The heart of any modern multi-channel CB radio is the voltage controlled oscillator (VCO). An unusual feature of the DNT is that it has TWO VCOs, one for RX and one for TX operation. Another unusual feature is its use of an MC145106P PLL synthesiser IC instead of a modern fixed N-code type. Consequently there is some scope for adding extra channels, albeit with some difficulty.

The TX VCO comprises Q5, L6, C34 and C36, plus bias resistors and decoupling capacitors. D6 is a variable capacitor diode whose capacitance is controlled by the voltage from pin 7 of the IC. As with all VCOs of this basic design, the frequency range can be extended by decreasing the value of the coupling capacitor C36. It would also be necessary to decrease the value of C119 in the RX VCO circuit.

The TX VCO output is taken directly from Q5 emitter to the RF preamp, Q23, where the frequency is doubled then amplified by the RF driver and output stages. The TX VCO runs at around 13.9 MHz. Its output also feeds Q6, Q7 then Q8 where it mixes with the output from the TX crystal oscillator. One of the frequencies resulting from this mixing is around 2.3 MHz (13.9-11.68) and returns via Q9 buffer stage to pin 2 of the IC. If this frequency matches the internally generated reference frequency in the IC (determined by the "N" codes selected by the channel switch) pin 8 goes high and transmission is allowed. Should the frequencies not match, the IC will alter the voltage supplied to D5 by pin 7 until the downmix frequency is correct. (Note that testing the voltage on pin 8 provides a simple means of determining whether the VCO frequency is correct.)

The RX VCO works in exactly the same manner but, because the RX crystal is 15.23 MHz, the output frequency of the VCO must be higher for the Downmix frequency to remain the same as that for TX. The RX VCO frequency will be around 17.1 MHz (27.8-10.695) and feeds the RX mixer transistor, Q2. The VCO frequency mixes with the received frequency to produce 10.695 which is allowed through the filter and passed through the Intermediate Frequency and demodulator IC. Note that a 10.695 oscillator held near to the rig would pass a signal through the I.F. stages to give a reading on the "S" meter, even if the VCO were not working - this is an extremely useful check to make on any rig which is not receiving since it can either eliminate or disclose a fault in the I.F. stages. Another useful check to make is to measure the voltage on pin 7 of the MC145106P. This voltage should alter in steps of about 0.06v as the channel selector is turned. If it does and if pin 8 is "high", then the VCO section is definitely working properly and the fault lies elsewhere. Do these checks for both RX and TX. Note that it is possible to make the rig transmit (albeit off-frequency) by connecting the junction of R57 and R58 to positive. This "enables" the Lock-Detect circuit. If the VCO is working at all, then an output should be produced, provided that the RF stages are adjusted correctly.

With any "dead" rig (lights up but nothing else) it is wise to check the supply voltages (Q13 and D11 form an AVR in the DNT) and the crystal oscillator(s). In the DNT, the RX oscillator is powered only during RX and the TX oscillator receives power only when the TX line is held low. The 10.24 works all the time, of course.

You will notice that there is a third varactor diode, D6. This diode capacitance is varied by a voltage from the microphone amplifier



# Midnight Express

transistors, Q17, 18 and 19 to produce frequency modulation during TX. D12 and 13 perform a clipping operation to limit the maximum deviation which is set by R84.

For those of you who are interested in modification I had better mention that my explanation of the VCO operation was oversimplified. In fact the downmix frequency for TX is NOT the same as that for RX. To achieve the correct frequencies pin 9 is pulled high during TX and pin 6 is pulled low. Pin 9, high, adds 128 to the "N" code and pin 6 low changes the reference frequency from 10kHz to 5kHz. This has to be done because, you will remember, the TX VCO output is doubled. The 5kHz steps thus become 10kHz steps in the RF output to give the correct channel spacing. Just for the record, the N codes for channel 1 are 168 RX and 168+256 TX. This is an extremely complicated way to use the MC145106P. Other rigs achieve the same object more simply.

A very interesting effect is obtained by swapping the tracks to pins 11 and 12. Put a frequency counter on and try it !

The DNT suffers from odd effects, often caused by maladjustment of the screwcores. It is particularly sensitive to the settings of the tx VCO inductor, L16 and L17. Effects such as reported "breaking up or transmission" on the top or bottom channels: transmit relay clacking in and out, and similar. It is important to ensure that the VCO is stable during TX (use low power) before tuning the TX coils. A high SWR can show up wrong adjustment where the rig might work OK on a dummy load.

Finally, note that the DNT board suffers badly from dry joints. Most of the faults you will come across will be caused by poor soldering but note, also, that ALL the RF transistors Q20, 21, 22 and 23 tend to go faulty. I have personally replaced each one of these in different rigs during the past year. The audio IC, too, is poorly "heatsinked" and tends to blow. Hope you find this sketch useful.

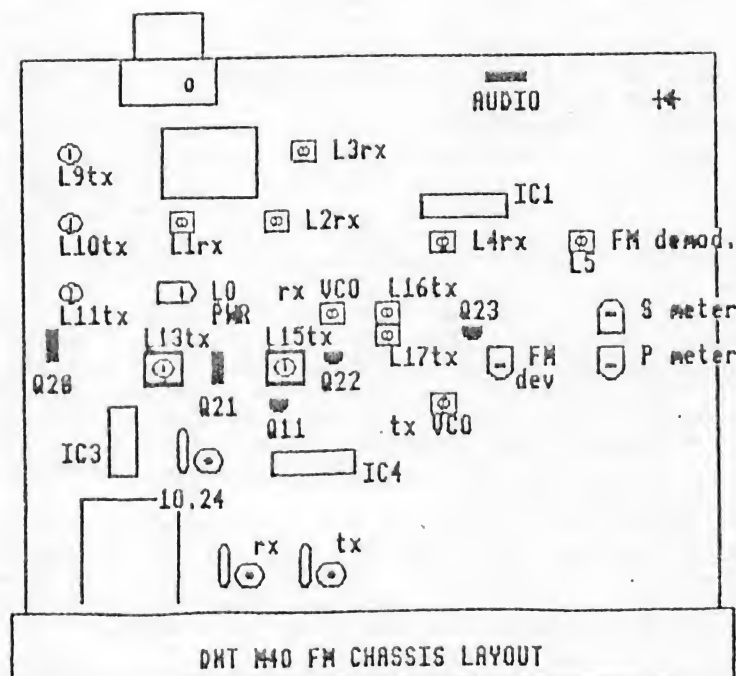


Fig. 26

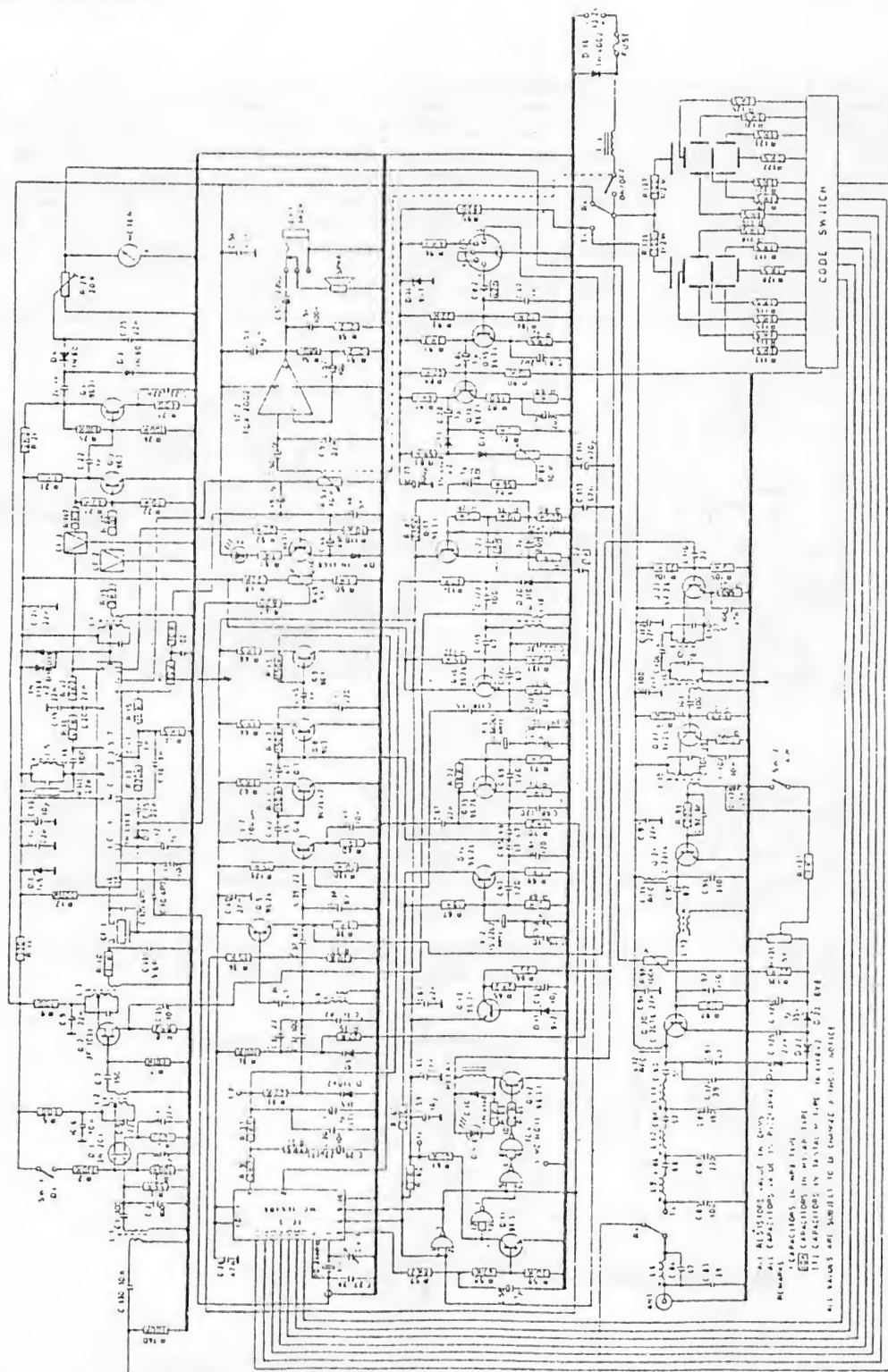


Fig.27 DNT circuit

Fig.28 shows the method of eliminating the audible beep from the loudspeaker when a "Piptone" beep by Baildon Electronics is fitted. The VN10KM is a VMOS F.E.T. which is available from most suppliers at about 50p. Please take care when handling the device since it can be damaged by static discharge. The VN10KM acts as a very high resistance when its gate voltage is zero but its resistance decreases to around 3 Ohms when a +ve voltage is applied. You may see other similar uses for the device since it is possible to use it directly in series with 8 or 16 Ohm loudspeakers to turn the sound off. Its "on" resistance is usually small enough to reduce the volume only slightly but, if you need to reduce the resistance, connect another VN10KM in parallel with the first.

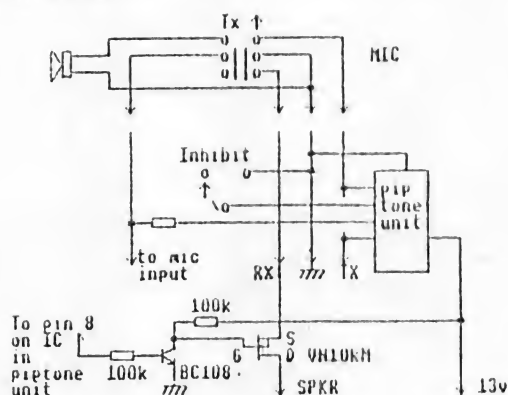
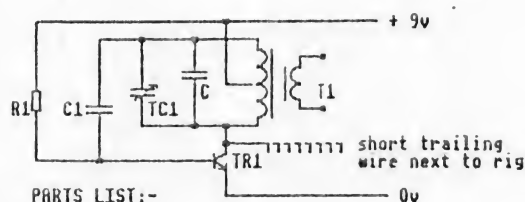


Fig.28



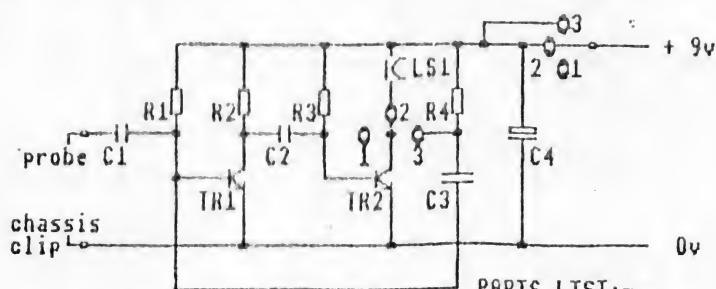
PARTS LIST:-

- R1 1 M
- C1 56pF
- TR1 BC107 or 2N4292
- T1 any common IF transformer should work (C is inside T1)
- TC1 30pF set to mid position. Tune slug to resolve CW or SSB signal.

Fig.29

Fig.29 shows the circuit of a Beat frequency oscillator (BFO) contributed by Mike Parks. This can be used to resolve an SSB signal with an AM rig. (Most FM rigs can also be used if the FM demodulator is bypassed. Take the I.F. output from the diode which feeds the "S" meter and connect it to the audio output IC. Note that the unmarked capacitor is inside T1.

Fig.30 shows Mike's circuit for a signal injector or signal tracer. A 2 pole 3 position switch is used to select the function.



SWITCH POSITION:-

- 1 = OFF
- 2 = TRACE
- 3 = INJECT

PARTS LIST:-

- R1,3 2M2
- R2,4 10k
- C1,2,3 1000pF
- C4 10uF
- TR1,2 BC109 or similar
- LS1 earphone 2kR min.

Fig.30

C1 should be 500v Mkg if used on valve equipment.

### "134" Discussion

The Cybernet PTBM134A0X board is one of the most widely used assembly in U.K. rigs but a lot of people still have difficulty in fault finding.

The 134 has a conventional VCO circuit, controlled by the LC7137 frequency synthesiser IC. The VCO has only a limited frequency range, however, (a deliberate design feature to improve stability) and since the VCO frequency on TX is around 13MHz (half the output frequency) and on RX is around 16MHz (output - 10.24), you will understand why the design requires the VCO centre frequency to be shifted down on TX. This function is performed by a transistor which connects a trimmer capacitor across the VCO inductor during TX. If the VCO requires adjustment, therefore, it is necessary first to adjust the inductor during RX, then adjust the trimmer capacitor during TX. If you monitor pin 14 of the LC7137 you will find that the voltage is around 7 volts when the VCO is correctly adjusted (ie within the "lock" range of the LC7137) and 0 volts when the VCO frequency is wrong. If you monitor the voltage on pin 15 you will see that it changes by approximately 0.06 volts each time the channel switch is turned. There are very few things which can stop the VCO/LC7137 combination from working so let's look at them.

Firstly, if the rig lights up, makes a noise, but otherwise refuses to cooperate, check the voltage on pin 18 of the LC7137. The zener diode or the low value resistor which feed this pin can become faulty since they are usually operating at their maximum design limits. If less than 6.5 volts, check the zener and resistor. If they are OK, check Q16 and D8 (AVR).

Assuming that the LC7137 is receiving power, check the 10.24 crystal is oscillating. If you don't have a scope or a sensitive frequency counter (you should have!) then build a 10.24 oscillator and use this to inject a test signal. Change the crystal or LC7137 if necessary.

If the 10.24 oscillation is present, check the lock detect pin 14. If this is high it indicates everything is OK but to be doubly sure check the voltage change on pin 15, too.

If the VCO is not in lock, try adjusting the VCO inductor during RX. If pin 14 remains low, ensure that the VCO is, in fact, oscillating. You really do need a frequency counter for this. If it is not or if you are not sure, replace VCO transistor Q1 and try again. If the VCO is oscillating, try disconnecting R2 (10k) and connect a 10k pot. between 0v and 7v with slider to R4. Adjusting this pot. should swing the VCO frequency up and down. If not, check D3 (varactor) and associated connections. Assuming all is OK here but the VCO still will not lock, check Q25 which feeds the VCO frequency back to pin 19 of the LC7137. If you still can not bring the VCO into lock, there is probably a faulty component or broken track between the LC7137 and the VCO.

If you decide that the VCO is in lock on both TX and RX then you probably have two separate faults: one in the TX section and one in the RX section.

A frequency counter or scope will show whether the VCO output is reaching T2 and T3. It is simply a matter of tracing the VCO frequency through Q3, T2, T3, Q4, T4, Q5, L4 to Q6 during TX.

On RX first hold a 10.695 oscillator close to Q10. If the "S" meter needle moves then the first and second I.F. stages are working, so ensure that the 10.24 crystal output is reaching the mixer stage, Q8, Q9. Try replacing CF1 which can go open circuit. If these simple



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checks fail, use a second rig on the same channel to transmit into a dummy load close to the aerial socket of the faulty set. Use a scope to trace the signal through Q7, Q8, Q9 to Q10. If you are still stumped, you missed something obvious!

### Making Amends

A successful rig doctor needs special qualities and an understanding wife. He needs tact, to deal with the customer. He needs to be reasonably competent in his work. He needs somewhere to lock himself away to concentrate on repairs.

He can't expect huge profits from rig repairs. The average CB radio costs less than £80, new, with some as cheap as £40; second hand rigs can be bought for less than £20. The result is that any repair costing more than, say, £10 simply isn't worth doing. Home-base rigs can cost more to repair because they are more expensive to replace and sods to work on.

It is a good idea to have a shop frontage. A rig doctor will often use his local garage or car accessories shop as a collection point. Surprisingly, perhaps, this can result in more profit than having customers come to his door, since it gives more time for repair work and attracts more customers. The shop will usually expect a small commission on repairs but the rig doctor will absorb this by reducing his prices. If he doesn't, then people will still come to the door, hoping to get discount. The advantages of a shop front are many: the shopkeeper is used to dealing with people politely, but firmly. He will act as a buffer against the occasional hassle from the customer. It's likely that he will pay for the repair the moment the rig is returned to the shop. This means cash immediately, without wasting repair time in chasing bad debts with resultant arguments and bad publicity. People no longer come to the door at strange hours (yes, it can happen) and the neighbours stop complaining about "weirdos with aerials that park outside". There is more time to do repairs without people chatting and looking over your shoulder.

Yes, it's nice to keep the customers a few wavelengths away.

It is odd, what customers complain about. I have never, never had a complaint about the cost of a repair (perhaps because I'm honest and charge fairly) but other complaints are numerous: the most common is that the rig is "off frequency" or "won't get out as far as it should". Inevitably when I collect it and check it again there is nothing wrong at all. People accept reports "on the air" as Gospel truth. If "Transistor Bender" up the road says "two pounds and muffled" then the rig doctor must have Knackered it.

I have to admit that, occasionally, the complaint is justified. Recently, for example, a gentleman, from Liverpool, came up here on holiday. On the way he'd bought an echo chamber kit and wanted it wired for his rig. The "kit" was an assembled circuit board in a box. All I had to do was connect the wires to the correct pins on the plug and socket. Next day I received an urgent call from the shop. The guy had returned, tried the echo chamber in his car and all it did was whistle.

Well, to cut the story short, I took the rig and the chamber back to the workshop and discovered that the echo chamber design was faulty and, although it worked on my rig and on the mike checker instrument, it malfunctioned on the customer's rig. A quick circuit modification and all was well. Let that be a lesson to me: always check mikes and chambers on the customer's own rig.

I can safely say that 80 percent of the faults I find are caused by SOME PERSON'S meddling or abuse of the rig in some way. I can't understand why people have to FIDDLE.

The jobs would often be cheaper if the owner had left well alone and brought the rig to the shop at the first sign of trouble. I NEVER charge for a quick check. Usually it is good for business, since the customer knows he will not be ripped off with an imaginary fault. Sometimes, however, when I return a rig to the shop with the note "No fault found after one hour soak test", the customer curses me to hell. "There must be something wrong", he'll say. "I can't get out" or "I can't pull in" as the actress.....

Invariably, the fault lies in the power supply, the supply lead, the patch lead, or the "other" microphone (which he didn't supply with the rig.)

The customer is always right.

My customers are always right. I set up a system of gaining information in the shop. I was sick of getting rigs for repair with no note attached. I printed some cards, hundreds of them. Each card asked for the owner's name and 'phone number, so I could contact him if a) I didn't understand his problem, b) the cost might be too high or c) the rig repair was urgent and he wanted to know when it was finished.

There was also space for the owner to write down the nature of the fault or what he wanted me to do.

You wouldn't believe the things that are written! "Rig Faulty" is the favourite. Great. That doesn't tell me much I couldn't have guessed. Oddly, these are usually the rigs with nothing wrong at all.

"Gets pulled down". I dread to think what that means and it's not my fault, anyway.

"Crystal blown". This is an easy one. He's connected it in reverse and the protection diode has gone short circuit. Unfortunately, since he's obviously very knowledgeable, it usually means he's "looked" inside it and twiddled every adjuster in sight. That reminds me of a breaker who brought me a Hy-Gain V the day after he'd purchased it, new. "Erm, I've adjusted it wrong", he said, sheepishly. "What", replied I, "one of the pots? Which one?". "Thirteen", said he. "Ah, RV13" said I, beginning to remove the mangled screws from the cover.

"No", he countered, "ALL thirteen of 'em"

If any of my customers are reading this, I do apologise, by the way. But let me give you some advice:-

Try, TRY to write down what is wrong with your rig. Simple explanations like "Won't transmit" are helpful. Don't try to be clever and put "RF transistor blown". It probably isn't. Set out the circumstances under which it went wrong. When did you notice it? (I don't mean last Tuesday, I mean was the sky filled with lightning and you on top of the hill at the time. Did it go wrong slowly or suddenly.) What was connected to it at the time? Have you tried a different microphone / power supply / supply lead / aerial / patch lead / fuse? Write an essay, if you must but PLEASE give me the facts. It could save my time and your money. If you have a circuit diagram, bring it in but don't bring the blooming mike bracket, slide mount, patch lead, mounting screws, supply lead or even the microphone unless you think it is faulty. If you are not concerned about scratches, don't bring the box and packing, either. These things get lost.

Tape a card with your name and fault report to the rig and, if you want to discuss it or want a quote, write your town and phone number. Don't use terms like "bleedover" which mean different things to different people: write "voices heard from another channel" or

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whatever you mean. Don't put an unqualified "sounds fuzzy". If it's distorted on receive, say so, otherwise I might think you mean distorted transmission. If you want to switch the Roger Bleep, tell me if I can use the "tone" switch or whatever. Otherwise I'll have to fit an extra switch which, after I've bought it and dismantled the rig to drill the necessary holes, wired it up and reassembled everything, could cost you an extra fiver! You see how a little thought can save you money.

It is quite important to say what is RIGHT with the rig, as well as what is wrong, otherwise you will be charged for a repair that you didn't want. For instance, if the mike lead is frayed and won't last another year I would repair or replace it. I have a reputation to maintain. So, if you are happy with a frayed lead, say so! If you don't mind a broken or missing knob, or a dud tone switch then say so.

There are, however some things which will be repaired, regardless. Many power supplies ("droppers") were made very badly, with switches in the neutral wire, fuses wrongly connected, earth connection pop-riveted in place. Some home-base rigs had no earth wire at all! If any rig doctor worth his salt finds a fault which affects the safety of the user he will correct the error. There is NO WAY that I will return a unit, to the customer, without a secure earth. That means a tag crimped or soldered to the green-yellow wire and bolted to the chassis.

Whilst on the subject of mains-operated equipment, I must make one point. It is amazing how many customers CUT OFF the mains plug before sending the unit for repair. Whether they need the plug for Aunt Annie's T.V. or they are afraid that I will steal it, I simply don't know. What I do know is that, before I can test the damn thing, I have to buy and fit a plug. Consequently, I charge for it. If the customer complains that he doesn't need the plug I charge for the removal.

If a plug is fitted, by the way, I will check it and if the cable is not correctly clamped or the plug is defective I will make a repair or replace it. I will NOT return it in an unsafe condition. I do not usually charge for labour in safety-related repairs of this nature.

There are a few things which you, the customer, can do to save money, before taking your rig for repair. If the rig is entirely dead, do check the fuse: if that is intact, try a different supply lead and power supply. If there is no sound from the loudspeaker, try another microphone. The microphone in most rigs provides an earth connection for the speaker. If that fails, connect an extension speaker. The wires on internal speakers have been known to corrode or snap. If there is still no audio but the "S" meter is going up and down (obviously receiving) then the Audio output chip has probably blown.

Nearly all rigs are fitted with a reverse protection diode rated at one Amp. If the rig is connected to the supply in reverse then the 2 Amp fuse will usually blow before the diode. If a higher rated fuse is fitted then the diode will probably melt and go short circuit. The fuse will blow and each successive fuse you try will also blow. I have had rigs with 13, 25 and even 35 Amp fuses! The rig can burn out completely with a large fuse fitted. It makes sense to fit a 2 Amp fuse.

If the rig transmits a carrier, but no modulation, try another microphone. If there is no sound from the speaker, too, then it is almost certainly the Audio output chip.

If the rig does not transmit and the red TX light fails to come on then the mike could be faulty. Otherwise, switch on another rig, nearby, on the same channel, without an aerial. If it picks up a

transmission from the faulty rig then the R.F. output transistor has probably blown. You still need the services of a rig doctor, but at least you know that it's not serious.

If the rig appears to be working normally but problems are experienced with transmitting and receiving over more than a mile or two, try the rig on someone else's set up.

This information is given to help you cure the fault if it lies outside the rig. It is not an open invitation to dive inside with a pair of fence-cutters and a poker (I've seen many examples of that).

Watt meters are not very accurate and must be used with a true 50 ohm dummy load (not an aerial or a bulb). Likewise an SWR meter will give the true reading for your aerial, only when it is connected close to the aerial. If there is more than a couple of feet of coax between the SWR meter and the aerial then you will obtain a correct reading only when the SWR is 1 : 1. That is why chopping the coax can alter the readings. Set the aerial with the meter close, THEN move the meter down to the rig end of the coax. Do check the reading once a week but don't leave it connected as it can cause interference.

Note that a power meter measures total power, so if you screw the output filter coils in the rig to let more interference through, you can expect the power reading to go up. This is a dangerous game. The power meter can not tell the difference between power at 27 MHz and interference at 55 or 110 or 220 MHz.

The power meter on your rig can be used only as a guide. Note the normal readings on channels 1, 20 and 40 when the system is transmitting properly. If the readings on transmit ever alter then you've got problems with coax (including patch lead) or aerial. It is NOT, however, essential to have a low SWR reading. Most rigs will tolerate up to 2 : 1 without losing any distance, and up to 3 : 1 is unlikely to cause any damage.

One final point. I mentioned that a rig doctor has to avoid arguments with his customers in order to maintain a good reputation and to avoid losing business. Well, the same applies in reverse. Very few rig doctors depend on repairs for a living wage. Most of us treat it as a pocket-money making hobby (yes, I do declare it for tax) and, therefore, some customers with a reputation for moaning or other annoying habits (like insisting on same-day service) find that, suddenly, repairs are costing more or taking forever. Rig doctors are only human. We make mistakes; we have feelings; we usually do our best; please treat us with respect because we're all you've got.

One last thought: don't expect miracles from your rig doctor: he is not a budding Einstein. If he were he would be working for N.A.S.A. not mending your precious rig !



### Interference

#### Home Base

When installing your receiver at home it is important to site it away from obvious sources of interference such as a computer, television or electrical kitchen equipment. Less obvious sources of interference are central heating thermostats (especially the one which directly controls the pump), Hi Fi equipment and video recorders. Remember that your neighbour might have some piece of equipment close to an adjoining wall.

In business premises there are more sources of interference to consider. All types of thermostat, controllers, motors, generators, telephone systems, automatic machinery, printers, electronic typewriters and fluorescent lighting can interfere with your reception.

As a general rule you should keep your aerial as far away from potential sources of interference as possible. This also applies to the coaxial cable which should be kept clear of other wires and metal pipes which might carry interference. If the cable MUST run near to another then try to use a zig-zag pattern rather than a straight line and avoid running the coax parallel to the other.

Interference can also be received from electrical equipment which is quite remote. Electric drills, lawnmowers, arc welders, computers, telephone systems and faulty power line connectors are favourites. The sound of the interference can be quite distinctive: a continuous whistle or trilling sound can come from a computer or its printer, from a monitor, a television or a telephone system. The sound from an electric drill or lawn mower is quite different and takes the form of a harsh whine with crackling superimposed. A washing machine produces a similar noise but varies according to the wash and spin cycles. Arc welders and thermostats produce a harsh crackling buzz with long intervals without noise. Thermostats tend to produce a regularly timed burst of interference of, for instance, twenty seconds duration every eight minutes whereas a welder is less regular. The time of day is a good clue to determining the source since welding is usually carried out during daylight whereas domestic boiler thermostats tend to operate on cold evenings. Televisions, too, are more likely to be in use during the evening.

A hand-held radio can be tuned in to the interference and used to trace the source. Bear in mind, however, that during conditions of tropospheric or ionospheric activity the interference might be coming from overseas!

If the interference is on only one channel, ensure that the radio itself is not faulty by checking with another. Try it with the aerial disconnected.

Cars are notorious sources of interference and there are two main types. The first is the whining noise from the alternator or dynamo which can be carried into the car through the wiring. A suppressor can be fitted to the large output terminal of the generator. A suppressor can also be fitted close to the radio itself, in its power lead.

The second type of interference is the regular clicking from the high tension output of the coil which feeds the spark plugs via the distributor. Ensure that all high tension parts are reasonably new and very clean. Replace suspect plugs, leads, distributor cap, rotor arm, condenser (if fitted), and coil.

Try to determine exactly how the interference is entering the radio. It could be directly through the case, along the power input or through the aerial socket. Carry out tests as follows:

Turn the squelch right off so that the loud hiss can be heard from the loudspeaker together with the interference. Disconnect the aerial plug from the radio and see if this removes or reduces the interference. If it does then some or all of the interference is being picked up by the aerial or by the coax. If disconnecting this aerial plug does not reduce the interference then dismount the radio and pull it as far away from the dashboard as possible. If this reduces the interference then the cover may be allowing interference through. Connect the cover to the car metalwork using thick wire or braid and bolts with lockwashers and nuts. If this has no effect try extending the power lead temporarily along the ground outside the car and connecting it directly to the battery live terminal (via a 2 Amp fuse next to the terminal). This should prevent the power lead from picking up interference from the car wiring. If it works, then an in-line filter should help or, failing that, connect the rig directly to the battery via coaxial cable but DO fit a 2A fuse right next to the battery!

### LTD BOARD

The LTD board by K.S. Services has proved to be a very popular modification. Here is a review of our experiences in fitting it to various rigs:-

The LTD board is an extremely clever design by Phil Morris of K.S. Services which enables one to produce the FCC band, midnight and a special -40 band (directly below UK band) on a previously legal rig. We cannot condone its use, however the method of working is of academic interest. The LTD board replaces the LC7137 or TC9119P synthesiser of the legal rig with its own MC145151P. An Eprom provides the appropriate divide codes for each frequency, taking its input from the channel selector switch. On the LC7137 version, a 74LS157 data selector is cleverly used to expand the range of codes available from the Eprom. This I.C. is not needed for the TC9119P version used in Audioline/Uniden chassis.

We fitted the LTD to three different rigs. The first was a Sapphire X4000 which uses the cybernet 134 board. The LTD board fits beneath the cybernet board without problem.

Getting the -40 channels to work was a simple matter, but the FCC channels caused a problem: the varactor diode, supplied with the kit, allowed the LTD to pull the VCO lower, but not quite low enough to attain channel 1 FCC. The advice given on the LTD data sheet was to add a transistor switch circuit to pull the VCO frequency lower. This required extra switch contacts and seemed overcomplicated so we decided to "broadband" the VCO, instead. We extended its range by reducing the value of the coupling capacitor, between the VCO transistor base and VCO coil. This mod was so successful that we no longer needed the extra varactor diode. The VCO range was extended right to the bottom of the midnight band.

The RF driver and output stages are not designed to pass the lower frequency bands, so a lot of time can be saved by monitoring the VCO frequency directly to ensure that it locks on TX and RX on all bands before trying to realign the RF output stages. We found it necessary to add a couple of capacitors to the driver stages to broaden the bandpass characteristics. A lot of patience, and a good 'scope is required to ensure a clean output waveform at all frequencies. Ideally, a spectrum analyser should be used. (No doubt you'll all buy a second-hand one when you have £7000 to spare.)

The final problem was to shift the frequency by 3.75kHz for the FCC band and midnight. We achieved this object by using a transistor "shifter" circuit. Unfortunately, we had to disconnect the Delta-Tune capacitors to realise the full frequency shift. It seemed logical, then, to use the now useless delta tune switch as the bandswitch. In addition we had to put a 12pF capacitor in series with the "I" input on the LTD board.

The second rig to undergo treatment was a Midland 4001. We used the same method as before to increase the VCO range. Some frequency drift was evident and the PLL seemed reluctant to lock. We finally cured the problem by soldering a 220pF capacitor, on the LTD board, between "L" and "0v". The RF stages were a sod to tune but we got it right, eventually. Our "shifter" circuit fitted easily to the crystal and gave the 3.75kHz shift with 39pF. (We also fitted the LTD board to a Midland 2001, using only UK and FCC bands, with FM/AM mod/demod added.)

Note that when the shifter circuit is used on a rig which uses the MC3357 IC, reducing the capacitance of the padder associated with the



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crystal increases not only the frequency, but also the output voltage which is fed to pin 1 of the MC3357. In the Midland rig the effect is to make the I.F. strip "deaf". The simple solution is to desolder one leg of C207 (5pF) but leave it in place. Alternatively a 1pF capacitor can be used to replace it.

The final type of rig we converted was a Uniden/Audioline. Here, I must confess, we were gaining confidence so we reprogrammed the LTD Eprom to give Super LO, too. In fact the final Audioline had UK band, HI-phantoms, FCC (mid), LO and Super LO!

Because of the difficulty in finding a position for the bandswitch, we fitted a miniature, stereo, jack socket to the rear panel and plugged in a rotary switch. Tuning the RF output stages was a doddle once we had shorted out a coupling capacitor, but the 3.75kHz shift was a swine.

The concept of the board is brilliant but the actual layout is too large and the board does not fit easily in the smaller rigs.

Although Phil assures us that the regulator on the LTD is up to the job, we fitted a 22ohm 1/2watt resistor in the 14 volt supply to the LTD. The resistor gets warm and allows the regulator to run a little cooler.

The MC145151P supply voltage can be as high as 9.0 volts, however the Eprom needs a supply voltage of 5volts and its outputs can be as low as 4.6v for a logic "1". The MC145151P requires an input of not less than 2/3 its supply voltage to register a logic "1", so it is necessary to operate it as close to 6.9v as possible. This voltage is conveniently derived from the zener which supplied the original synthesiser IC. The zener may be padded with diodes or replaced with one of the correct voltage.

Some rigs tend to be a little unstable with the LTD board so we suggest that a 220 pF disc ceramic capacitor is fitted on the LTD board between "L" and "0v" (although Phil says the later version is stable).

Note that, whilst in most rigs you can connect the T/R connection directly to the microphone socket, in the Amstrad 901, Nato 40FM and similar you must connect it to the collector of Q22 to avoid interfering with the "beep" operation.

Finally, you really need good test gear to do the job properly. I know you can't all afford £7000 for a second-hand spectrum analyser but you must at least use a 30MHz scope and an accurate frequency counter. It is all too easy to create "Sproggies" on the transmitted signal. Please bear in mind that a rig so converted may not legally be used.

### WOBBULATOR

A wobulator is an oscillator whose frequency can be "wobbled" about a centre point. For CB radio the centre point is the Intermediate Frequency of 10.695 MHz. The I.F. pass band is 10kHz wide since that is the width of each channel. In practice the pass band should be slightly less than this to minimise interference from adjacent channels. We can use the wobulator to adjust the I.F. pass band in the following way.

Although not essential it will help alignment if the VCO is disabled, or its output disconnected from the mixer stage.

Connect the oscilloscope "X" output to the wobulator "X" input and the oscilloscope "Y" input to the I.F. output transformer via the diode, capacitor, resistor arrangement shown below.

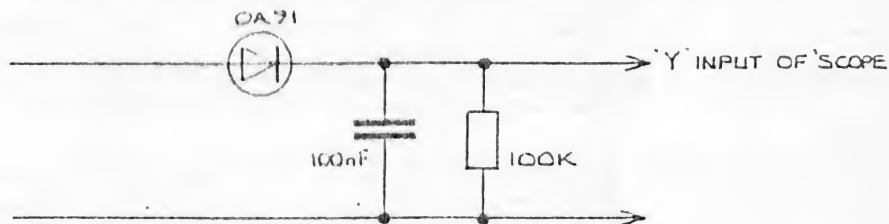


Fig. 31

Set the sweep speed to about 12Hz. "Y" sensitivity to about 200 mV/cm.

The wobulator is set to give a steady output of 10.695 MHz which is loosely coupled into the first mixer stage (the transistor before the 10.7 filter in the rig) simply by placing the wobulator output lead close to that stage. The "S" meter will give a reading which should be adjusted to about S4 by altering the position of the lead. Tune the I.F. transformers for maximum reading. The oscilloscope (D.C. input) will show a steady line which can be used to indicate the signal amplitude if no "S" meter is fitted.

Turn the wobulator deviation control up and the pass band response should be displayed on the oscilloscope. Adjust the scope controls and the deviation until the waveform takes up one third of the screen width and the amplitude is sufficiently high to see the shape, clearly. Adjust the coupling to the mixer stage to minimise the input so that it is just sufficient to give a clear trace on the screen.

The I.F. transformer(s) can now be adjusted (very slightly) to give the best approximation to a square wave on the screen. (Usually NOT very square so adjust for a nice, symmetrical, rounded hump in the centre of the screen).

If a crystal filter has been fitted, which does not match the impedance of the I.F. stages on each side of it, it will not be possible to adjust the transformers to produce a satisfactory pass band: the oscilloscope trace might well show a pronounced dip in the centre of the "square" wave. The I.F. circuit impedance must be increased until a proper match is achieved.

### CIRCUIT OPERATION

The circuit is shown in Fig. 32 and works in the following manner:-

TR1 and its associated components form a Voltage Controlled Oscillator whose frequency must be adjusted to 10.695 MHz. TR2 forms a buffer stage, with L2 and its internal capacitance acting as a

resonant circuit, to produce a relatively pure sine wave at 10.695 MHz.

D1 is a varactor diode whose capacitance determines the frequency of the VCO. The application of a varying voltage to R7 causes the frequency to "wobble" up and down with the maximum deviation away from the centre frequency being determined by VR1.

In order to set the centre frequency a D.C. voltage is applied to D1 via R5. A straightforward potential divider would do the job but the frequency would tend to drift with temperature and mechanical disturbances. To stabilise the centre frequency, we have used a standard frequency synthesiser I.C. found in most C.B. radios. It has the advantage of being cheap and operates well at the moderately high frequency we are using.

The function of IC1 is as follows:-

The VCO output is sampled and fed to pin 19 whence it is divided by a programmable divider and the result is compared with a frequency standard. If the two are different the output voltage on pin 15 changes to correct the VCO frequency error.

The output from pin 15 is passed through an internal amplifier between pins 16 and 17. The associated components form a low pass filter to slow the response time, otherwise it would correct the frequency deviation we are trying to produce!

The frequency standard is derived from X1 whose output at just below 6.4 MHz is divided by 2048 in a fixed internal divider to produce 3.12 kHz. The 10.695 VCO sample is divided by 3423 in the programmable divider to give the same 3.12 kHz. The I.C. has a total of 80 possible divide ratios which are selected on pins 1 - 6 and 20. The 6.4 MHz crystal is a standard crystal, chosen because it happened to match one of the divide ratios available (3423).

#### SETTING UP

Adjust CT1 until X1 is oscillating at 6.3989 MHz. Use the smallest coupling capacitor possible between frequency counter and crystal to minimise loading effects which can alter the frequency.

Adjust L1 until the output frequency on C16 is 10.695. There should be a definite position of lock where L1 can be turned slightly either way without altering the frequency. If not, check the circuitry around IC1. With a high impedance voltmeter on the junction of R4 and R5, adjust L1 again until a reading of roughly 2.5 volts is obtained. (Half the rail voltage).

Finally, connect an oscilloscope to C16 and adjust L2 for maximum amplitude and purest waveform.

Note: The prototype was used with an "X" input voltage of 20v peak to peak. If your oscilloscope output voltage is higher, please increase R7 accordingly.

The low-pass filter network comprising R1, R2, R4, C1, C2 and C5 is designed to work at a sweep speed of around 500Hz. If you try to use a speed much lower than that the PLL circuit will "jitter", causing multiple traces and distortion. At higher sweep speeds you will observe rounding of the waveform as the frequency passband of the I.F. circuit is exceeded.

The wobulator can also be used on 10.7 MHz I.F. receivers in which case the "hump" will appear to the left of the oscilloscope screen centre. The LC7137 divide ratios can be adjusted, together with the crystal trimmer capacitor to give a 10.7 centre frequency, if desired. (Connect pin 1 high and tune CT1 for 6.3981 MHz).

Note: Some rigs such as Maxcom, Midland etc. have no I.F. output transformer, as such. In these rigs the circuit of fig.30 must be connected to Q108 collector.

# Midnight Express

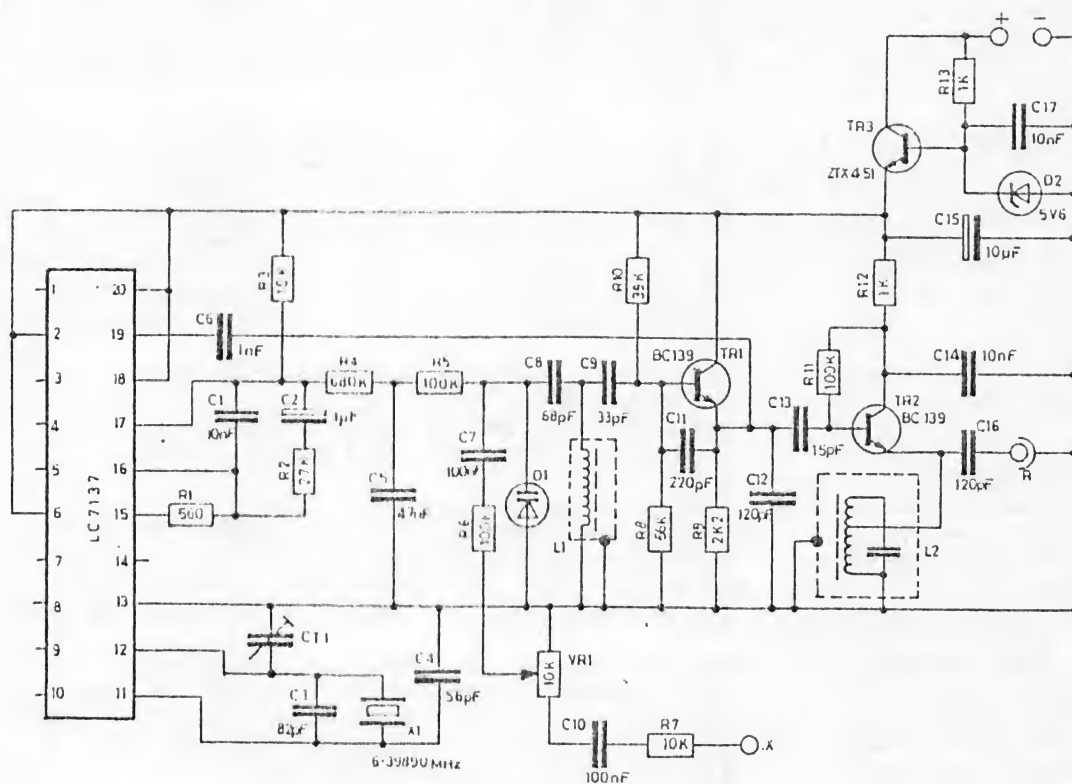
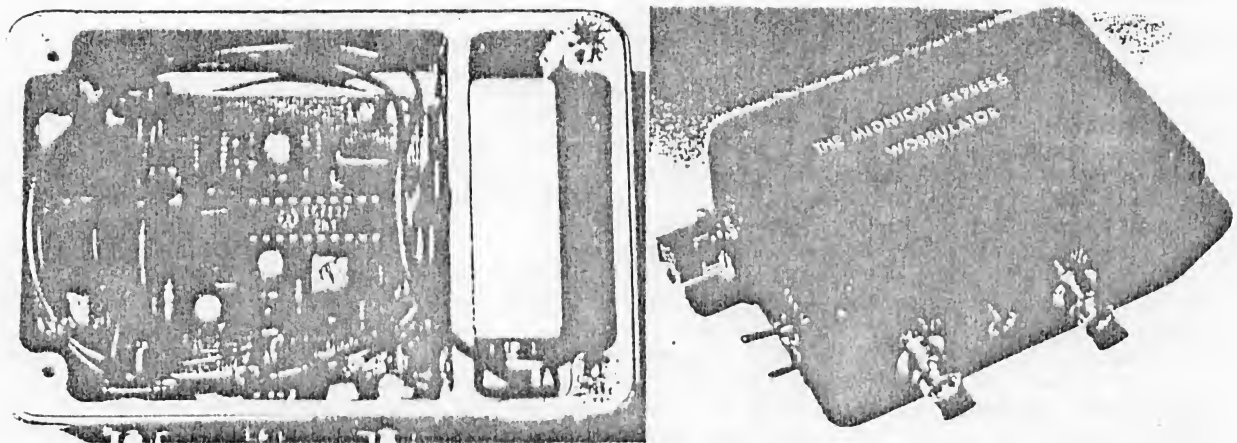


Fig. 32. Wobbulator Circuit



We used a socket for each permutation, adding more sockets as each new permutation arrived on the workbench. Had we realised from the start just how many there are we should have used a four pole twelve way switch (at least!), and just one socket of each physical type.

[illegible]

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## Midnight Express

Lou Franklin "Supersparks" has been in the CB mail order business for more years than he likes to remember. The "Specialist", from S.J. Tonks (CB Components) recently flew across the Atlantic to visit him and this is an account of their discussions.

Stepping into the July sunshine from the air conditioned comfort of Phoenix airport was like walking into an oven. The temperature at 6pm was an incredible 112°F. The sky was cloudless and there was a pungent smell which I can only describe as a mixture of hot bricks and burnt turnip! The temperature inside Lou's 5.7 litre Pontiac Firebird was even higher and we stewed for two minutes until the compressor forced the air temperature down to a comfortable 80°F.

The journey through Phoenix to the borders of the exclusive Scottsdale area where Lou lives was an experience which even jet lag couldn't blunt. Phoenix is a sprawling city more than 20 miles wide. There are very few buildings of more than one storey high and the land is substantially flat but with mountains dividing the city in two. I had expected there to be no greenery at all, save for the famous Saguaro cactus plants; after all, Arizona is supposed to be all desert! To my surprise I saw grassed parks and golf courses, flowering shrubs, trees and rose bushes. Unlike Tucson, Phoenix has plentiful supplies of water and irrigation is widespread but it sure is HOT!

Speed limits vary from 25 in residential streets to 65 outside town and the radar detector on Lou's dashboard beeped almost continuously as we passed buildings with microwave security systems and shops with automatic doors. Curiously, you can turn right through a red traffic light and overtake vehicles on either side. The flow of traffic actually seemed very sedate compared with that of cities in Britain.

Everyone carries containers of drinking water in case of a breakdown out of town. It's not much fun to be stuck in the open where temperatures can reach 130°F and CB radio can be useful in such a situation. The radio amateurs are in a better situation, however since a portable 2 metre rig can access the local repeater and allow communication with towns as far away as Albuquerque and El Paso in the next state!

Interestingly, Lou's house was not the only one with a large array of aerials. Many tri-banders were evident in the district and Amateur radio in, apparently, very popular in Phoenix. Recently retired Senator Barry Goldwater has a couple of enormous beams in the grounds of his house. Large CB aerials were also evident in the poorer districts and, judging by the size of them, planning permission is not a problem! So, in the air conditioned comfort of Lou's TV lounge (and wearing nothing but shorts) we got down to the question and answer session.

Q How did you start in the CB business, Lou?

A I got my first class radio operator's license a long time ago so you can appreciate that I do know a little bit about radio. I've had a lot of different jobs related to transmitters and antennas. I've worked in a Radio Shack store. I even worked as a Disk Jockey for a time. The CB stuff really started one day in a parking lot when a truck driver mentioned that his rig had stopped working. I offered to have a look and when I got the screws out the fault turned out to be something simple like a wire fallen off (it was a long time ago). This seemed like a source of easy money so the next day I put a sign on the side of my car using magnetic strip and sat there in the parking lot

just waiting for the business to come rolling in. Sure enough, within a few days the word got around and I would collect rigs from the truck drivers, take them into the rest room (toilet) and use a portable soldering iron to fix them on the spot.

Q What prompted you to write your "Screwdriver Expert's" Guide?

A I was having trouble getting basic information and reckoned that others must have the same problem. Although I guess I didn't know a lot about rigs then, when I saw the mess that some of the "repaired" rigs had gotten into I decided I could make some more money by writing a simple book for the guys out there who obviously hadn't a clue what they were doing. Of course it's a bit out of date, now, but I keep adding bits in the back and people are still buying it!

Q What about the "PLL Book"?

A Well, you can't fix rigs without knowing what these Phase lock Loop chips are doing and there wasn't just one single book on the market with all this information so I decided to write one. It was a lot of hard work to collect all the data sheets and I made a lot of mistakes in the early issues which were just sheets stapled together. At the time I was living in an apartment and the only place I had to store these books was on the balcony! I'm currently gathering information on the newest chips which will be added to the next revision when I get round to it but my new book is taking up most of my time right now.

Q Yes, I'd heard you were writing a sort of super "Screwdriver Expert's" manual. When will this be ready?

A Well, I really wish you hadn't asked me that! I got the library of Congress number for it two years ago and booksellers keep writing me for prices. It's very embarrassing, but the book is nearly finished now. I'm actually on the last chapter. The problem was, it grew so large that I had to reformat the whole book into two-column text with a smaller font to get it to fit and that's no easy matter in Wordstar, especially with the large number of illustrations to be pasted in.

Q So what is the price of this volume going to be?

A Well, I reckon it will have to sell at about 30 Dollars to make a reasonable profit, which isn't bad for a 400 page book which is packed with so much information.

Q Will it be ready by Christmas?

A I sure as hell hope so. It's costing me over 20,000 Dollars to print and with more than two years' work gone into it I need to start seeing some return.

Q Are you looking for a UK distributor? I was thinking that with our recent expansion at S.J. Tonks we could maybe shift a few thousand for you!

A Well, Mike Devereux of "Nevada" in Portsmouth has already negotiated for the distribution rights but, if he doesn't confirm his interest, it might be a case of "first come, first served".

Q I see. Returning to the history of your CB business, I expected you to have a big store in the middle of town, rather than running everything from home.

A I used to have a shop in California which a friend and I ran together but, when he had to leave because of bad health, I couldn't carry on alone. Besides, I've never been very keen on retailing and it's so much easier to run the mail order business from the comfort of home.

Q But don't you find it difficult to cope with all the orders, alone?

A Fall is the busiest time for me but I do try to maintain a two-day turnaround of orders. When things get really busy my wife will

## Midnight Express

help to make up the kits and fold catalogs and I have other people to help with assembly work while I do the boring paperwork and answer any stupid complaints. I've recently installed a telephone answering machine which basically says "Don't phone, write!" and this has saved me a lot of time. Guys would phone me and expect to chat for hours. I'd like to talk but, when you're trying to run a business virtually single-handed, it's just not feasible to spend time on the telephone like that. Also, because we are several hours behind the rest of the USA I was getting calls at 6 am!

Q Do you get a lot of complaints, then?

A No, I guess not. It just seems like a lot and some of these people are so stupid it makes me really angry.

Q So you don't rate the intelligence of the average CBer very highly?

A Well the number of guys I deal with who truly know what they are doing can be counted on the fingers of one hand. Some of them don't wait more than a week after sending an order before they write to ask where it is! They don't seem to realise it takes longer than that even if I send by return of post. A lot of them are so stupid they can't even solder, let alone read the resistor color code. Look at this, for example. This guy has returned a board which, he says, he has assembled exactly according to the instructions. But the first thing I see is the red wire soldered - not in the hole marked "red" - but to pin 2 of the IC underneath the board. That means 13 volts on the input pin of the amplifier! The guy's an idiot. Not only that but the soldering looks like chicken shit and there's filthy brown stuff between all the joints - maybe flux. I don't know - and some of the resistors which my photo shows clearly as being flat on the board are standing up. I don't have time for this sort of thing any more.

Q So what can you do about returns from people who have no idea how to assemble a kit?

A Well, all I can do is post it back at MY expense with a polite note saying we can repair it and get it to work at a cost of 25 Dollars an hour or he can find somebody to help him who knows what he's doing. The trouble is that when I receive an order for a kit I have no way of knowing whether the guy has ever used a soldering iron before in his life. Maybe we should only offer fully built up modules but that costs more and there's a lot of guys out there who enjoy building kits. Here's another letter from an idiot. "Dear Sir, I don't understand the technical parts of your "Screwdriver Expert's" Guide. Can you explain the following?" Then there are two pages of questions: no stamped addressed envelope or cash enclosed and I can't read his signature. Honestly, if this guy can't understand THAT book then he must have an IQ of 30 and he certainly shouldn't be messing inside a rig. Into the trash with it. Here's an order for a catalogue but no money.

Q Yes, and it's written in Spanish!

A Yeah. I speak Spanish but how the hell does he expect to understand the catalog, let alone the kit building instructions, if he doesn't speak English? Beats me.

Q What do you think of British CBers?

A You mean the ones that write to me? Well very few have written. I don't think I've had more than 5 enquiries during all the years I've been doing this. One thing I notice is that they NEVER put their address on the outside of the envelope like we do here. Sometimes they don't put it on the inside, either!

Q So you don't think we're a very bright bunch?

A Oh, I didn't say that. Judging by yourself and people like Mike



Midnight Express

Devereux I'd say that there must be quite a few clever CBers in Britain but they never order anything from me!

Q Yes but your prices are comparatively high.

A I do try to price my kits realistically and the average American has money to burn whereas it seems to me that in Europe you are a tight risted bunch. Maybe it's just because salaries are so much higher in the States.

Q I notice you charge for your catalogue.

A Yes, maybe I lose some business but I post thousands of catalogues each year and maybe only one in ten results in an order.

Q And you seem to be getting mostly dollar bills in the mail!

A Yes I do. My wife is paranoid about the tax man and makes sure that I report every penny I earn but it's certainly more convenient to handle dollar bills. I do ask people to send paper money for the smaller amounts and to round up to the nearest dollar to avoid posting coins. Some people are stupid, however, and wrap up coins in cardboard and scotch tape in order to send the exact amount. They don't realise that it costs them 20 cents extra postage to save 10 cents in cash. Also it takes time for me to unravel all the coins from the cardboard and scotch tape and doesn't put me in a very good mood to deal with their order!

Q Do you accept orders by Barclaycard Visa and Mastercard?

A Yes but it's a bit of a nuisance for small amounts and people never remember to put down the expiry date so I have to write back to them.

Q What would be your advice to people from Britain who want to order from you?

A If it's one of our standard products like an active IF filter or a book then they should try S.J. Tonks first since overseas postage is expensive. If they need specific information from me like, for instance, a circuit diagram for a specific American rig or extra information about a PLL chip then if Steve Tonks can't help they could write me with exact details of what they want. Please keep it brief and because it will involve my driving into town to the printers to use the photocopier I have to make a sensible charge. To make it easy for me I suggest they get a 5 dollar bill from their bank and send it to me with the enquiry. If there is any doubt whether I can help they should send two dollars with their enquiry, plus a label with their full address including postcode and the word "England" or whatever. All this talk of money makes me sound like a mercenary but I am in business to make a profit and if people want information they should be prepared to pay for it and to make it quick and easy for me to reply.

Q Changing the subject to the legal issues of CB in America, I understand that you can't use FM?

A Yes, FM is illegal but we can use AM or SSB on all 40 channels.

Q But you sell an FM board. What does the FCC think of that.

A The Friendly Candy Company? Oh they are very upset and keep sending threatening letters. They've already imposed a 500 dollar fine for selling Multimodes in the past so I have to keep my nose clean. I can't sell kits for linears or frequency conversions like I used to but they can't do much about the FM kit which uses parts you could buy in any Radio Shack store.

Q What effect has the introduction of the new 10 metre Novice Band had on your business?

A I've had a number of enquiries from people who want to convert rigs to the 28.1 - 28.5 MHz novice band but there hasn't been enough time to consider it yet. I'm sure there's a big demand, however.

Q You'll be interested to know that we have already developed a conversion board for 10 metres.

A Yes. That is interesting. I'm sure I could sell anything like that. The American market is so much bigger than the British market and I also do a lot of business with Canada and Australia. In fact, now that radar detectors in cars have been made illegal in Australia the interest in CB radio seems to be growing even stronger over there.

Q How do you generate your business. Do you advertise a lot in the American CB magazines?

A Ha! There isn't a single American CB magazine left. It's really strange. There must be a big market for a CB magazine in America but nobody seems interested in publishing one, now. However, to answer your question, a lot of my business comes from personal referrals but I put a monthly ad in most of the radio mags like QST and Radio Electronics. Recently I had to change the wording because the FCC objected to the word "modifications" but everyone knows what I sell, anyway. This year business has been so good that I am stopping all my advertising. I simply don't need it.

Q Well, thanks for the chat, Lou, and the ice cream. Maybe we should try out the pool, now?



Ham International sideband rigs are renowned for sounding awful on F.M. when the old legal UK frequencies are used. Here is an explanation of what is wrong, followed by details of how to fix it!

Fig.34 represents audio modulation of the carrier about its centre frequency of 27.825MHz on CH77 HI band. Frequency modulation is achieved by feeding the modulating voltage output of the audio amplifier to a varactor diode which is connected across the 20.555MHz downmix crystal. The varying capacitance of the diode "wobbles" the frequency above and below its nominal value at a rate which matches the audio input frequency. This change in frequency of the downmix oscillator modulates the carrier frequency.

The crystal frequency can, however, be pulled only about 5kHz in each direction. Since the usual maximum deviation used for CB is  $\pm 2.5$ kHz, therefore, the crystal frequency must not be tuned closer to its limiting value than 2.5kHz or "clipping" will occur.

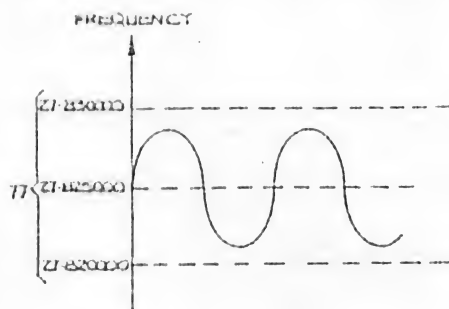


Fig 34.

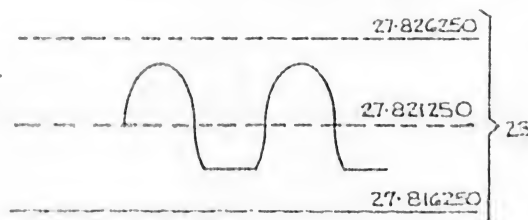


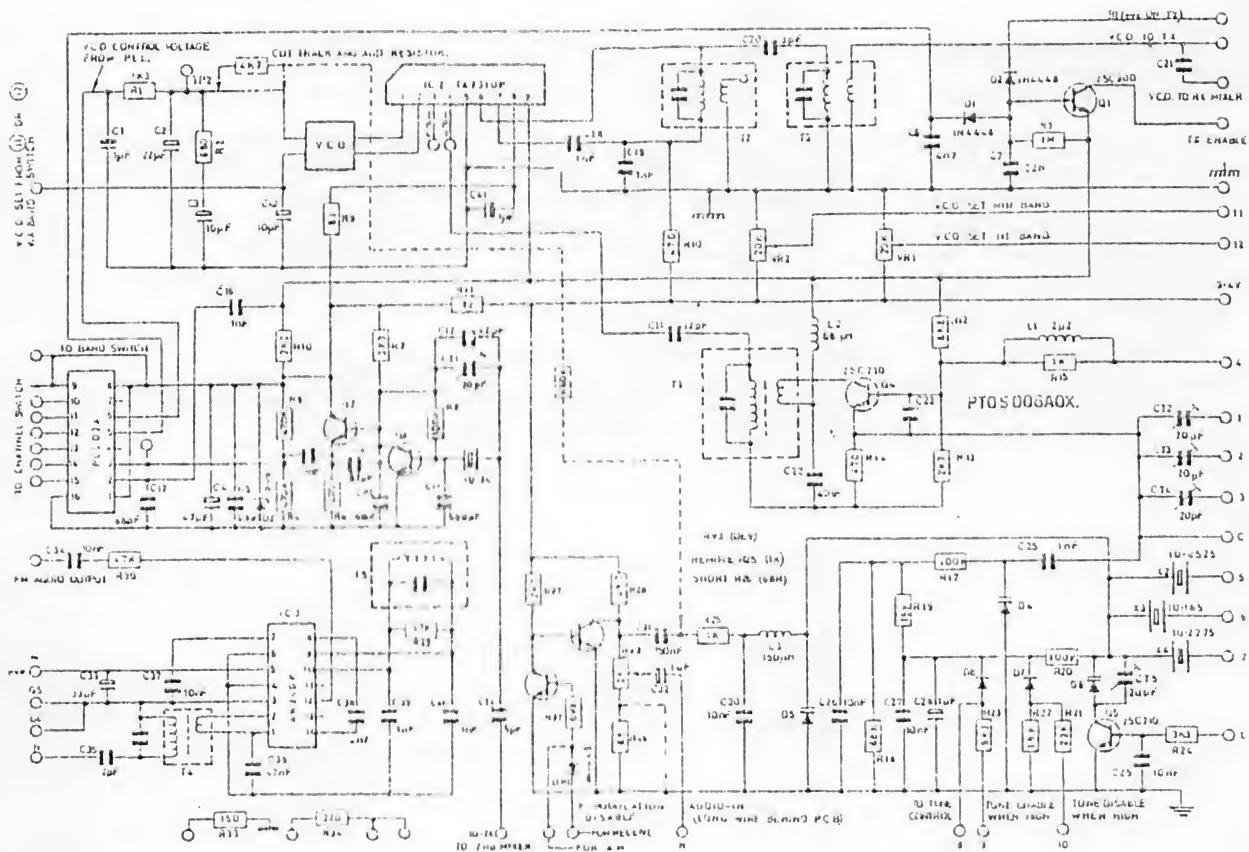
Fig.35

Fig.35 illustrates the clipping caused by tuning the carrier frequency down to 27.82125 (CH23 UK). The crystal oscillator has been pulled 3.75kHz away from its centre frequency, leaving only 1.25kHz range: but we are still trying to modulate it up and down by 2.5kHz.

Well, there's the technical explanation of the problem! We can't easily change the crystal oscillator to allow it to be pulled further off frequency, so do we have an insurmountable problem?

Of course the answer is no. All we want to achieve is modulation of the carrier frequency which is affected by both the downmix oscillator and the voltage controlled oscillator. In fact we can modulate the VCO frequency quite readily without incurring the problem of clipping.

Look at Fig.36 which shows part of the PTOS006 AOX board circuit (with the errors corrected from the manufacturer's original diagram!)



↑

Increase modulation by linking across R26 if necessary.

Fig. 36

The VCO block contains a varactor diode which receives a DC voltage feed from the PLL02A phase detector output. This voltage determines the frequency of oscillation. If we modulate this voltage we will effectively modulate the frequency. In practice, all we need do is to isolate the VCO from the smoothing circuit (we don't want to smooth our audio input!) by connecting a resistor Rx between the VCO block and TP2. In fact 4k7 works well. The VCO block is then coupled to the audio signal via a resistor Ry (680k). Remove the existing 1k resistor R25 and connect Ry to the free end of C31. The modulating voltage will now be too large so short out R26 (68 ohms) and adjust RV3 for 2.5kHz maximum deviation.

The tone of the transmitted audio can further be improved by connecting 100nF capacitors across C152 and C154 near the Audio output IC. Check the deviation, again. This whole job can be completed in less than ten minutes and makes the Ham owner very happy indeed!

(If the manufacturers had designed the rig in this way they would have saved a capacitor, a choke and a varactor diode).



### Wally Walloper

How often have you wished that the rig belonging to the Wally up the street would suddenly suffer terminal deafness so he would switch off and go to the pub? The circuit of Fig.37 is enough to make anyone thirst for beer but, we must add, is entirely illegal to operate.

TR3 is a 27MHz oscillator which can transmit a few milliwatts locally with a range of 30 metres or so. The output frequency is modulated up and down by the multivibrator circuit comprising TR1 and TR2. The transformer consists of 15 turns of 24 swg enamelled copper wire on a 5mm former. An output filter coil former from a scrap rig may be used. The coil is tapped at the 3rd turn to form the secondary winding for the aerial. Adjust the frequency by means of a screwcore.

The entire circuit can quickly be built up on VeroBoard and runs from a PP3 9 volt battery. The aerial is (ideally) a 9 foot piece of wire (that's 2.7 metres for you youngsters) which can be used to hang the unit in the nearest tree. Alternatively, if all else fails, it could be used to suspend the Wally from the tree. (This page is being written on the morning of April 1st.)

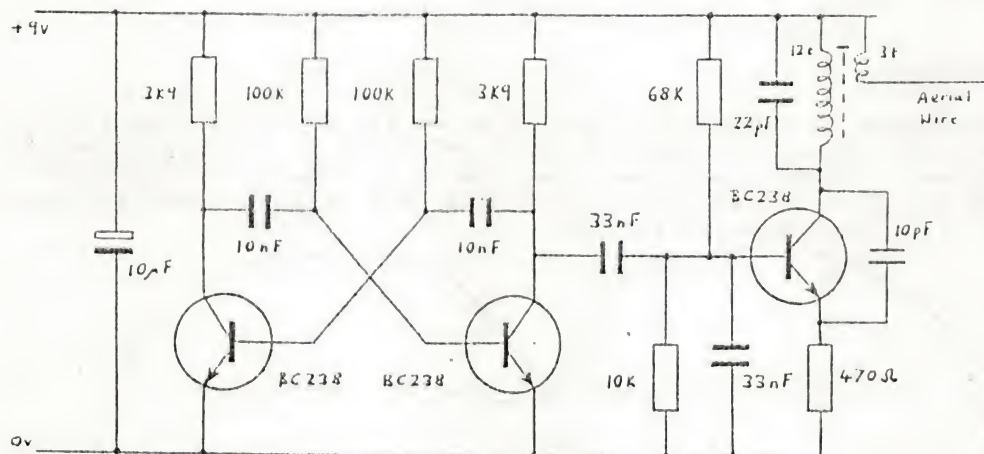


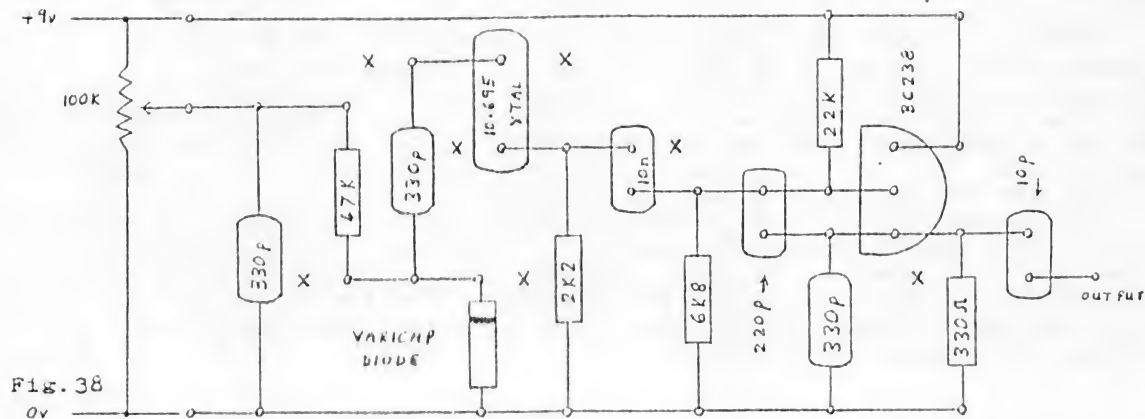
Fig. 37

Fig.38 shows a simple circuit which can form a very useful piece of test equipment. When the oscillator is running at its centre frequency of 10.695 MHz it can be used to check a rig in the following manner. Suppose you have a rig which appears virtually dead on RX, apart from a slight hiss from the loudspeaker. The fault could lie anywhere between the aerial and the audio output stage. By holding the output wire from this oscillator close to the I.F. section of the rig, however, you can tell if the fault lies before, or after, the 10.695 MHz filter. If the "S" meter shows a reading then the I.F. section is functioning and the fault must lie at, or before, the filter. If the oscillator produces no- or minimal- response, then the fault probably lies after the filter or in the voltage supply to the RX section.

The potentiometer controls the voltage on the varactor diode and, thereby, the frequency of oscillation. If the oscillator is held close to a working A.M. receiver it is often possible to "tune in" SSB signals which, without the help of this circuit, would be unreadable.

## Midnight Express

The successful demodulation relies both on the frequency and the strength of the oscillator signal. Consequently, it will be necessary to adjust the distance between the oscillator and the rig whilst turning the potentiometer.



## Twin Trucker

X = CUT VEROBOARD TRACK

It is possible to double the gain of an aerial by connecting it to another. The connection needs to be carried out in a specific manner and the gain increase will be broadside to an imaginary line drawn between the aerials with a corresponding loss of gain along the axis of this line, as shown in Fig.39

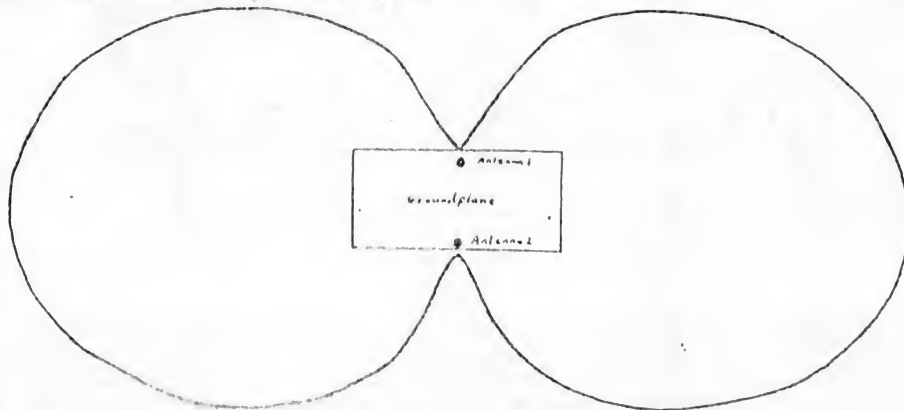


Fig.39 Sketch to show relative gain of "Twin Trucker" aerial system.

The two aerials must be absolutely identical and each should have its length set initially on a ground plane by connecting it to a rig with standard 50 Ohm coaxial cable via an SWR meter. A special coaxial harness must be made for the final installation, as follows.

Two pieces of 75 Ohm TV coax are required. The length of each piece, including any connectors, is shown as "L" in Fig.40 and is calculated as follows:

$$L = \frac{50}{F} \text{ where } F \text{ is the band-centre frequency in MHz}$$

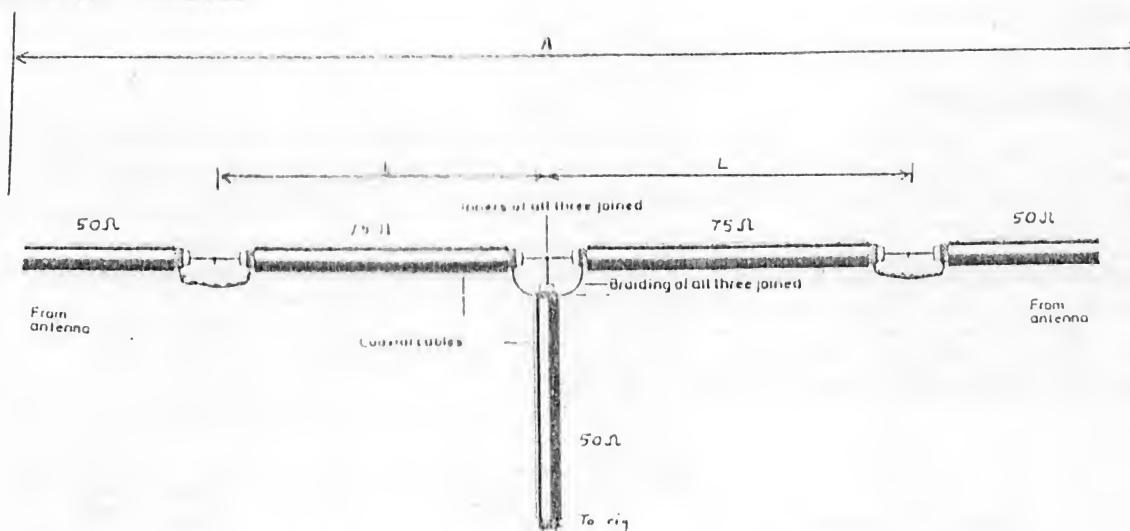


Fig. 40 Layout of the "Twin Trucker" system.

Example: UK band channel 20 = 27.79 MHz so  $L = 50/27.79$

$L = 1.8$  metres

The distance between the aerials is  $A = 300/F$

So, for the example,  $A = 300/27.79$

$A = 10.8$  metres

The two lengths "L" of TV coax must be joined to the 50 Ohm coaxial connection to the rig by means of a "T" piece and plugs, or by direct soldering inside two triangles cut, perhaps, from a tin-plated can. The can must be soldered carefully to the braid but insulated from the inner cores of the cable. DO NOT melt the insulation!

The outer ends of the TV coax must be connected by means of plugs and in-line connectors to the 50 Ohm coax from each aerial. Unless the aerial instructions say otherwise, the length of this 50 Ohm coax may be cut short to any convenient length.

#### Notes:

The lengths are critical and the system will work correctly only within a 40 channel bandwidth. The distance "A" is also important since it controls the radiation pattern. The system is, therefore, impossible to install on a car. A large ground plane is required between the aerials and should stretch as far forward and backwards as possible since this distance will affect the gain in that direction.

The maximum possible forward/backward gain is 3dB relative to the original gain of one aerial alone. 3dB means twice the gain but note that this shows only an extra half "S" point on a correctly calibrated meter. The major benefit is in cutting out interfering signals from the sides.



The circuit of Fig. 41 can be built into a microphone and is powered by a single hearing aid cell of 1.3 volts. With the microphone trigger in the receive position the electrolytic capacitor is charged up. When the microphone trigger is pressed the battery cell is disconnected and the multivibrator oscillator tone sounds briefly as the energy in the capacitor powers the circuit. Since the frequency of the tone changes as the voltage drops the actual sound is a little unusual!

An on/off switch may be fitted in series with the battery cell if you wish to switch the sound off, but the current drain is very low and the cell will last a long time even if no switch is fitted.

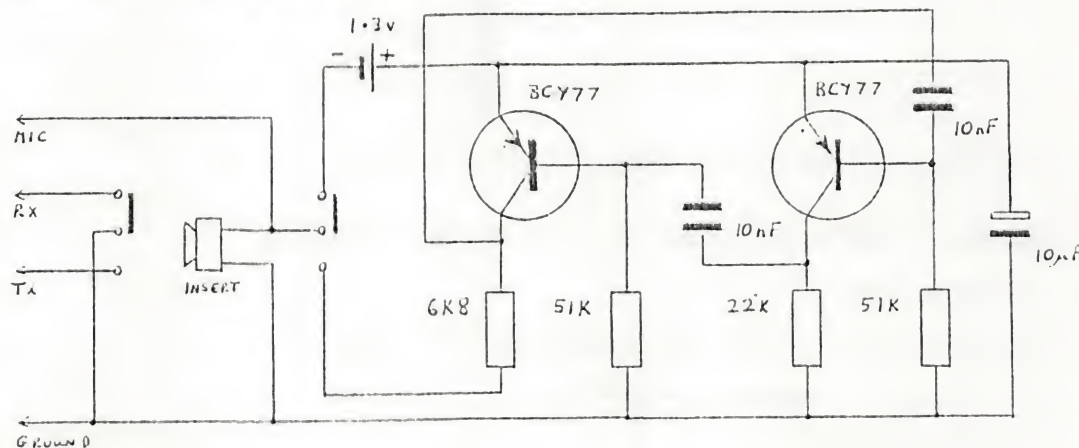


Fig. 41      Ground 0

Diode Matrix Band selection in Cobra 148 GTL DX and Superstar 360 FM.

The circuit of Fig.42 shows the existing band-selection diodes in the later Cobra/Superstar rigs and also the additional diodes which can be fitted to create extra bands. The extra low band provides only 22 channels but the 15.000 MHz crystal can be changed to 14.460 MHz to shift all bands down one (losing Super HI but gaining all of Super LO).

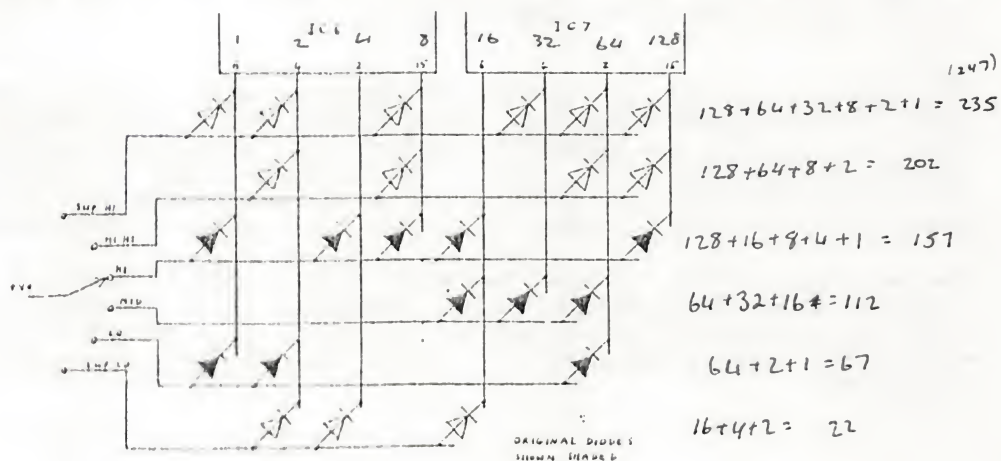


Fig. 42



Midnight Express

I have worked on electronic designs for the past 25 years (since I was 11 years old, in fact) and I have a university degree in electronics. My experience in industry is quite broad based and goes back over 15 years. A lot of my time has been spent in dealing with Telecommunications equipment however and, whilst I am quite clever at some things, I admit my total ignorance of others. Maybe that is why I coined the handle "The Specialist".

This preamble is just background to the point in hand, however, which is that now and again I find it necessary to ask a person for advice on a technical subject. When I write to people, my letters are always polite and I try to make it a golden rule never to criticise anyone - especially in writing! I freely admit that I am not the cleverest person on earth and that everyone does SOMETHING better than I can.

Imagine my surprise, therefore, when I received a slightly unhelpful reply to a request for help which I wrote to a radio amateur. The person in question has written a number of articles in magazines and is very clever, intelligent and knowledgeable and I am at a complete loss as to how I managed to offend him.

Never the less I thought you might be amused by the style of prose, so here for your edification and entertainment is a copy of that letter from a radio amateur. Long live CB !

Birchington Essex  
Nr Bishop's Cleeve  
Herts  
24th March 88

Dear Sir,

Did I not make it clear in my last letter to you? I do not wish to deal with you in any way, shape or form. I find you ignorant and stupid. Do not write to me ever again. Don't even acknowledge this letter. Get Lost, You are a waste of time.

H. Anderson

"J" Channel Addition (27.572 MHz)

Frequency modification is illegal and, now that we have another 40 legal channels, quite superfluous but when the UK channels were becoming a little crowded around town I had a look at adding one extra channel to a Harrier WT2 handheld. The actual fitting of an extra crystal running at 10.230 MHz was easy but you might be interested in the other feature which was to make the channel display the letter "J" when the extra channel was selected. Fig.43 shows the circuit.

The transistors have to carry quite a lot of current and I used ZTX450 but BC337 or 2N3704 are equally suitable. Diodes can be 1N4148 or similar.

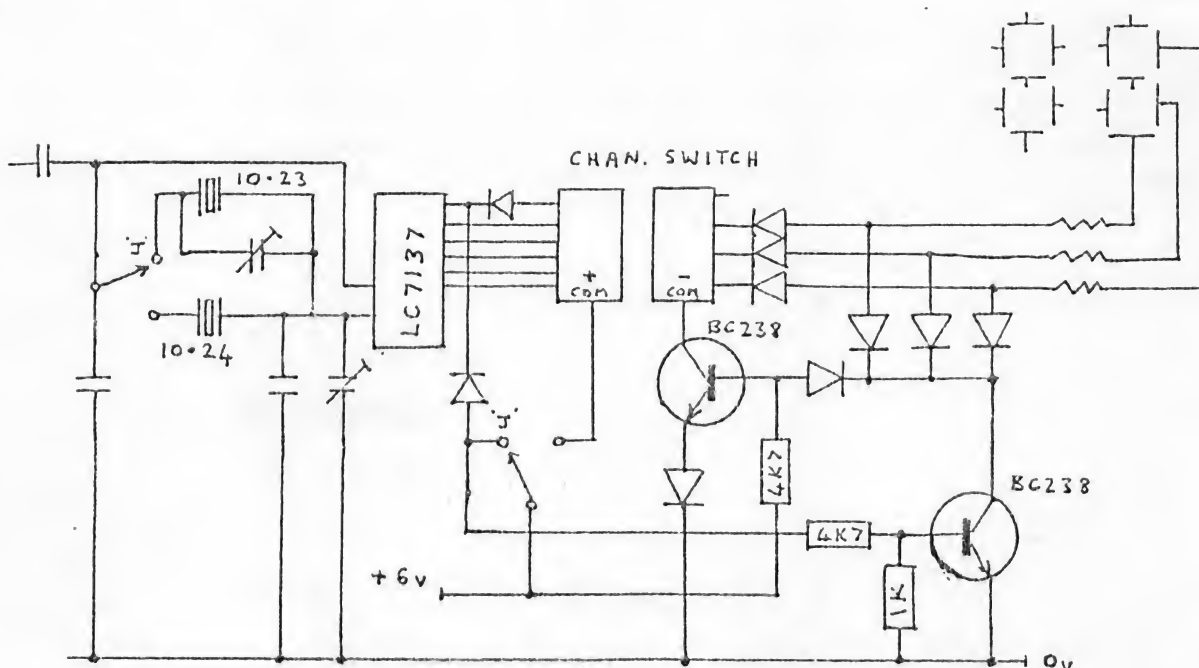


Fig.43

IDEA (from G. Ball)

Add a switchable ANL function to Major 120/Formac 88 type rigs as follows:

Remove wire link marked R51 and fit a 10k resistor. Solder a wire in hole 29 and connect it to a single pole switch. Connect the other switch terminal to a volt track on the PCB. The switch will now allow you to disable the ANL function. The audio sounds brighter and the receiver is more sensitive. It is also possible to switch the NB function but, since there is no audible difference, it hardly seems worthwhile.

Adding AM to an FM rig

Compare the AM "Formac" type circuits with the PTBM134A0X/135A0X Cybernet types used in many FM rigs. You will find that the lower half of the I.F. and squelch sections are very similar. It should be possible, therefore, to add the AM detector diode (D10 in Formac) and a few resistors and capacitors on VeroBoard to add a switchable AM/FM facility. This modification would be especially popular on the "new" legal UK channels which are used for AM transmissions in America and also in parts of Europe until 1991. The following circuits show how to make your FM rig transmit on AM. (None of these mods are legal.)



Fig. 44

Cut track between Pin 6 MB3712 & C30  
Cut track so no voltage to collector  
of driver transistor only, leaving  
all other components in circ.  
Set o/p Power to highest.

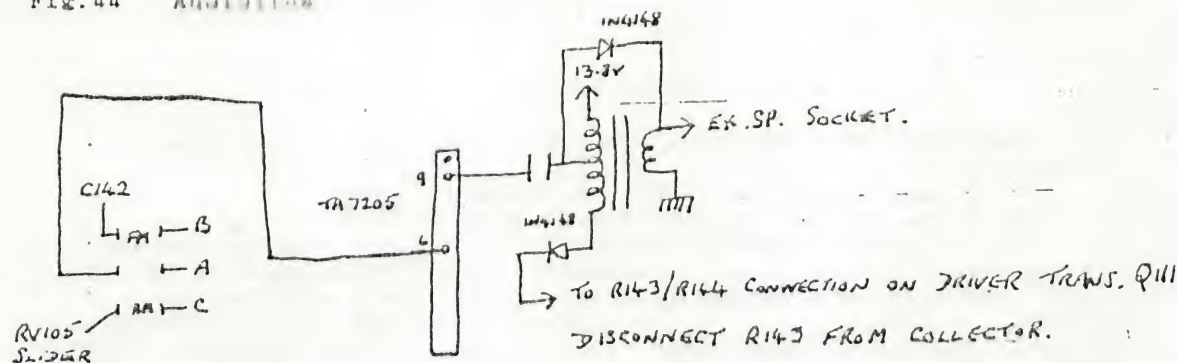


Fig. 45 Midland

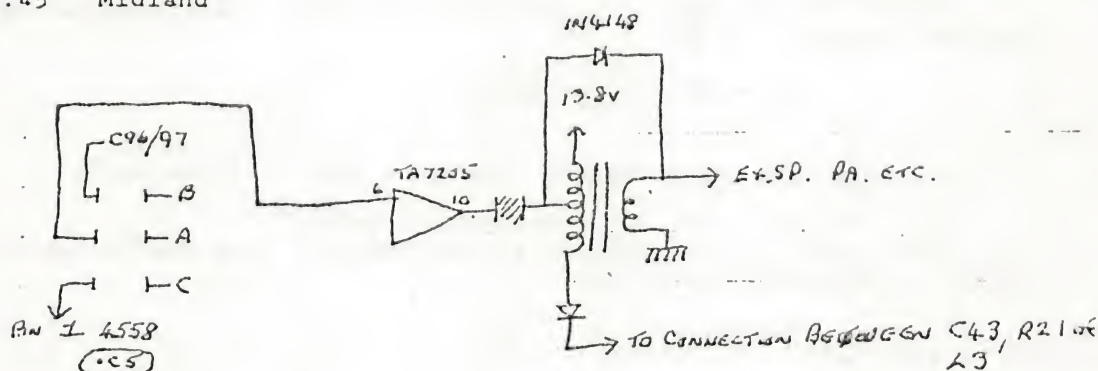


Fig. 46 Cybernet

DISCONNECT SUPPLY TO DRIVER



A Question of Loss

I don't know about you, but decibels leave me a little confused. Consequently, when the going got a bit rough and my brain started to hurt, I enlisted the help of a friend.

"I have this RG58 coax", I explained to him "which is 20 metres long (that's 65 feet for oldies like me) and I am stuffing 4 Watts in one end. If the frequency is 27MHz and the losses quoted by the cable manufacturer are 0.5dB per 10 metres, how many Watts reach the aerial?"

"Well, I'm glad you asked me an easy one." replied Terry "I'd say about 3 Watts, but let's work it out accurately. If you call the power going in P1 and the power coming out P2 then the equation for the gain (or loss, in this case) is":

$$-dB = 10 \log \frac{P_2}{P_1} \quad \text{so} \quad \text{Antilog}(\frac{-dB}{10}) = \frac{P_2}{P_1}$$

thus  $P_2 = P_1 \times \text{Antilog}(\frac{-dB}{10})$  ,but  $P_1=4$  Watts,  $dB=1$  for 20m

therefore  $P_2 = 4 \times \text{Antilog}(\frac{-1}{10})$  and, since  $\text{Antilog}(-0.1) = 0.794$

$$P_2 = 4 \times 0.794$$

$$P_2 = 3.177 \text{ Watts output}$$

"So I'm losing nearly a quarter of my power in the cable!" I exclaimed.

"Yes, but nobody will notice" replied Terry.

"But how can you say that? It's disastrous!"

"No it's not because, remember, it's only a loss of 1dB and if 1 "S" point on the receiver represents a power difference of 3dB (\*) then 1 dB will be a needle thickness" and nobody will see that. Besides, the losses due to aerial inefficiencies and poor matching will be far greater than 1dB". (\* 3dB power change represents 6dB voltage difference at the aerial, measured by the "S" meter.)

"But what happens if I connect the rig to a burner?"

"Well, if your amplifier produces 100 Watts, say, then we can use the same equation to get":

$$P_2 = 100 \times \text{Antilog}(\frac{-1}{10})$$

$$P_2 = 79.4 \text{ Watts} - \text{that's a loss of } 20.56 \text{ Watts}$$

"Ah, but that's a lot better than 3 Watts!"

"Well, yes, but consider what the receiver will see. If we go back to the original equation":

$$dB = 10 \log \frac{P_2}{P_1}$$

then  $dB = 10 \log \frac{79.4}{3.177}$

$$= 10 \log(25)$$



- 14 or just over 4 "S" points increase.

"But that seems hardly worthwhile!" I observed.

"OK, very few "S" meters are calibrated to that accuracy. Consequently you'll find some reports will give you an increase of 2 "S" point and some will tell you 6 but, the whole point is, that the actual extra distance you will get by using an illegal burner is a whole lot less than the fine if you're caught!"

"I think I'm convinced but why didn't you put a negative sign in front of the dBs this time?"

"Because we were working out a gain, not a loss in power. In fact the actual answer would have been the same if we'd called it a loss and divided 3.177 by 79.4 but this way the maths is slightly easier."

"Yes. I think even I could work that out!"

"OK. Lets consider what happens when you flick from low to high power, that is from 0.4 Watts to 4 Watts.

"I think I can do that":

$$\text{dB} = 10 \times \log\left(\frac{4}{0.4}\right) = 10 \times \log(10) = 10 \times 1.0000$$

-10dB which is just over 3 "S" points!"

"That's right, so why use high power when the guy up the road reports your signal as "S9" on low power?"

"Yes, it does seem rather antisocial because flicking the switch will reduce the reading only to "S7" which should still be perfectly readable, but won't cause half as much interference to other people."

"Right. However, you must also realise that these figures are true only for brand new, best quality coax. If the coax is the cheap stuff with big holes in the braid or old and water-logged, then the losses will be higher. You should be very wary of buying cheap cable. If it's cheap and nasty the shielding braid may be skimpy and if it's second-hand it might be corroded. That leads me to another point. When you install the coax outside you must waterproof EVERY joint of the coax and the aerial. A lot of people make do with electricians PVC tape, but this is never very satisfactory. You should use either self-vulcanising rubber tape which bonds to itself or Denzo tape which is the stickiest, goodest most waterproof tape you can get. Alternatively, you could use a sealant or waterproof glue but choose carefully. If you use silicone sealant remember that it WILL absorb some moisture so spread it on thickly!"

"Returning to the subject of burners: what happens in the situation you described if the burner is connected, not next to the rig, but at the end of the coax near to the aerial?"

"Well, the power reaching the burner will be just over 3 Watts, of course, consequently the burner will be slightly under-run. This is a good thing because you will still get your 79 Watts out or probably more, but the interference will be much lower for several reasons. Firstly, you are under-running the burner and that will reduce the harmonics which would otherwise be produced. Secondly, since the power from the rig is reduced, the harmonics from the rig will also be reduced so there will be less interference to amplify. Thirdly, there will be far less radiation from the coax itself if you are stuffing 3 Watts up it instead of 100. Fourthly, the burner will last longer. The only drawback, of course, is finding a power point on your roof!"

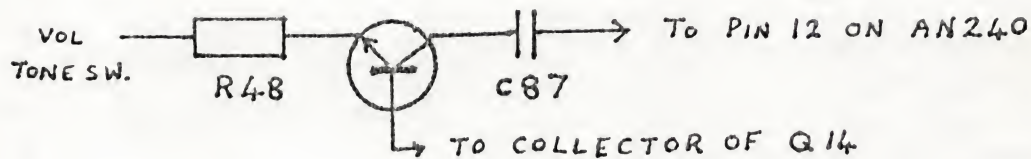
## Midnight Express

### More Hints!

Cybernet 134. Change C109 (10uF next to Q14) to 1uF to speed up the squelch action.

Adding 3k3 in series with squelch pot will keep out signals under 1 "S" point (which are too noisy in any case).

Add a BC108 or BC238 as shown below:-



Don't check to see if your soldering iron is hot by putting it on your tongue - it affects the taste of your tea! (Thanks, Steve)

Fidelity CB3000 base station: connect 18k resistor from unused end of RF gain control to regulated +ve supply. This increases the effectiveness of the control.

### Uniden Conversion to FCC frequencies:

Connect the TC9106 on top of the TC9119 piggy back style but leave pins 3,4,5,6 and 7 free.

Cut track to pins 4 and 5 TC9119.

Link TR17 collector to junction of D6 and R33.

Connect pin 5 TC9106 to bottom of your new bandswitch.

Connect pin 5 TC9119 to top of the switch.

Connect track previously disconnected from pin 5 to switch slider.

Change C62 to 18pF.

Solder 33pF across C04.

Tune VCO and output coils for operation on both bands.

### JWR M2

To improve squelch, replace the 470R resistor beside pins 9 & 10 with a higher value.

Rig lights up but no TX or RX. Try replacing D203 (5v6 zener diode).

No TX can be caused by the demise of R327 and R217.

Fluttering oscillation on both RX & TX: replace audio IC (also Icom).

On AM rigs, no Audio and RF carrier output but no modulation on TX is usually cured by replacing the Audio IC.

Low TX and low RX can be caused by a faulty RF output transistor, especially in Stalker 9 type sets.

Rig keeps blowing fuses: check insulating washers and bushes on all heatsink transistors.

Make your own low power dummy load by soldering 20 x 1k resistors in parallel (found in most scrap CBs).

Fit an "S" meter bulb at the end of a ballpoint pen tube to facilitate reading of component numbers deep inside a rig.

### Fidelity 1000, Cheiza etc.

"S" meter indication but no incoming sound: replace Q8.

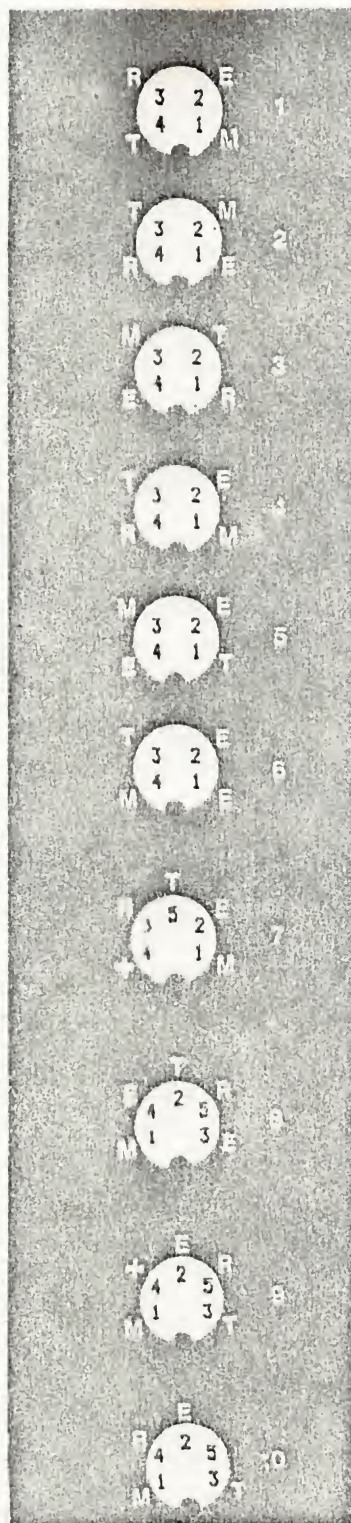
Transmitted modulation low or zero: replace Q11.

Change binary codes to get CEPT band. (Order DA3 conversion!)

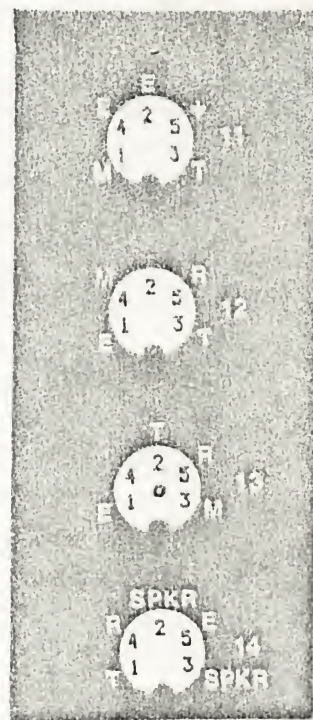


# Midnight Express

Academy (3)  
 Alpha 4000 (13)  
 Amstrad 900/901 (1)  
 Atron CB507 (2)  
 Audioline (all) (2)  
 Binatone 5 Star (1)  
 Binatone Route 66 (1)  
 Binatone Beam Breaker (1)  
 Breaker 40 FM CEPT (1)  
 CB Master 2040 (8)  
 Cheiza (1)  
 Cobra 146 GTL (2)  
 Cobra 148 GTL DX (2)  
 Cobra 19 GTL (2)  
 Cobra 19X (8)  
 Cobra 21 GTL (2)  
 Colt 210/295/355/720 (8)  
 Colt 320/444/510/870 (1)  
 Colt Excalibur (1)  
 Commtel (1)  
 Commtron VIII/CKX (8)  
 Communicators (1)  
 DNT M40 FM (11)  
 Domico Convoy 1 (1)  
 ELFTone (3)  
 Eurosonic Euro-2 (5)  
 Falcon FCB1281 (1)  
 Fidelity 1000/3000 (3)  
 Fidelity 2000 (1)  
 Formac 88/120 \* (1)  
 GE 3-5804/3-5805 (12)  
 GECOL GT856-B (3)  
 Grandstand Bluebird (9)  
 Grandstand Gemini (10)  
 Grandstand Hawk (1)  
 Grandstand Hurricane (12)  
 Ham Concordell & III (1)  
 Ham Explorer (1)  
 Ham Int UK (1)  
 Ham Jumbo (1)  
 Ham Major M-100 (1)  
 Ham Multibeam (1)  
 Ham Viking (1)  
 Harrier CBX (1)  
 Harvard 400M (5)  
 Harvard 420 M (1)  
 Harvard Good Buddy (4)  
 Hy-Gain V (1)  
 Icom ICB-1050 (1)  
 JWR M2 (1)  
 Jaws Mk2 (8)  
 Kraco KCB-4030 (1)  
 Kraco KCB-4004 (2)  
 LCL 2740 FM (11)  
 Lake Manxman (3)  
 Legionaire (1)  
 Maxcom 4E/20E/21E (8)  
 Midland 2/3/4001 (1)



Midland 6001.7001 (1)  
 Midland Transportbl (14)  
 Mini Midland (8)  
 Murphy Hbase CBH1500 (6)  
 Mustang 1000/3000 (1)  
 Nato 2000 (1)  
 Nato 40 FM (1)  
 New Formac 88 \* (8)  
 Pegasus-7 (1)  
 Planet 2000 (1)  
 Pres. Adams (2)  
 Pres. Andrew J (2)  
 Pres. AR-144, AX-144 (2)  
 Pres. Dwight D (2)  
 Radiomobile CB201/2 (1)  
 Realistic TRC2000/1 (12)  
 Rotel RVC 220/240 (1)  
 Sapphire X2000 (3)  
 Sapphire X4000 (8)  
 Scooper MKY-440B (2)  
 Scooper MKY-550E (2)  
 Serpent UK 4000 (1)  
 Shogun (7)  
 Stalker (all) (2)  
 Sun 401 (1)  
 Superstar 120 FM (2)  
 Superstar 2000 (1)  
 Tokai (3)  
 Tristar 727/47/77/97 (1)  
 Uniace (all) (2)

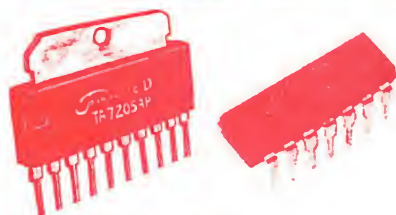








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